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**Conducted by MAJOR B. BADEN-POWELL, F.R.A.S., and E. S. GREW, M.A.**

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## Is Public Interest in Science on the Decline in England?

WE sincerely trust not. The British Science Guild has lately been incorporated, under the Presidency of the new Minister for War, with the special object of guarding against such a contingency, and has all the appearance of having come to stay. And yet there is some evidence to the effect that periodicals devoted to scientific subjects are not read to the extent that we would like to see. During the past year no less than three such journals have died of inanition. One, a magnificently got-up and very well edited magazine of technics, another, a most useful organ of metallurgy, and the third an interesting record of nature. Yet these have each failed to attract sufficient readers to justify their existence. It is a monstrous pity! What is the cause? It is generally contended that scientific interest is growing apace, and that the general public is daily becoming more imbued with a craving for knowledge. If so, why these failures in the scientific press? As regards our own position, although not very long ago we also were deploring the scanty support we were receiving, times have changed, and, possibly in consequence of the disappearance of the other journals, the outlook is now far brighter than it was, and our position seems assured. Still, considering the circumstances, it might have been expected that a larger proportion of the reading public would have gone in for a journal devoted to science, while of not too technical a character. The modern public is, however, very critical, and even hyper-critical. "None but the best" is now the cry. Such a sentiment is praiseworthy, but it can be overdone, and if the acme of perfection is not to be obtained it is surely better to take the less good and encourage it to improve. Half a loaf is better than no bread, and the sale of many half loaves enables the baker to give more for the money.

A really good organ of popular science is a most desirable institution. We know, only too well, our shortcomings, but without more encouragement and a larger circulation it is not possible to produce a periodical such as we should like to see. We would, then, make a strong and earnest appeal to all who have scientific progress at heart, to co-operate in improving this journal by doing what they can to increase our circulation. If only each one of our readers would take two copies instead of one (and the spare copy makes an acceptable present to many a poorer worker in science), with our circulation doubled, we would gladly undertake to double the size of the paper, and pay more for suitable articles and choice illustrations.

It would be of the greatest assistance to the immediate improvement of the journal if all those who propose to take it in regularly would subscribe on the new five-years' system. This has been specially arranged to be of the greatest benefit to the reader, saving him much expense and trouble.

We occasionally have opinions from individual readers, but these are often contradictory and bewildering in their suggestions. We are anxious to ascertain the wishes of the majority, and with such object we enclose in this number a post card in the hope that all readers will kindly enter thereon their opinions and post it to us.

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# The Coloration of Mammals and Birds.

By J. LEWIS BONHOTE, M.A., F.L.S., F.Z.S., M.B.O.U., etc.

(*Continued from page* 294.)

Let us now study for a short time the migrant birds that breed in Polar regions. These may be divided into two classes :—

(1.) Those from the temperate regions, which gradually breed as far north as is consistent with their wants.

(2.) Those that winter in the tropics and breed in the extreme north, but not in the intervening region.

We need not notice the first class here, as they belong properly to the north temperate region, from which they are stragglers.

The second class consists, for the most part, of bright-coloured birds that assume their bright livery in the tropics, and that wear in winter a duller dress, assumed in northern regions*. The Lapland bunting (*Calcarius lapponicus*) is a good example, for the cock has a bright black and red breeding plumage, much brighter than that of its near ally, the snow bunting (*Plectrophenax nivalis*), which has a much more northerly winter habitat.

Another good instance of a bright-coloured northern breeding bird is the red-breasted swallow (*Hirundo erythogaster*), which passes the summer in North-East Siberia, and the winter in Burma, and countries to the south. This bird does not, as far as I am aware, moult in these northern regions, and, consequently, as we should expect, retains its bright red colour, which was assumed in the tropics (where the temperature and food are conducive to high vigour) throughout the year.

It would be impossible to enumerate all the birds which may be considered in this class ; the Limicolæ offer many examples, and the knot (*Tringa canutus*) may be taken as very typical.

This bird assumes in early spring, when in the tropics, a very deep chestnut plumage. It then migrates to the extreme north to breed. After breeding it moults and becomes a dull greyish white bird, so that both its plumages are in keeping with the colour characteristic of the regions in which they are assumed. Now it has long been a puzzle to me why† the young knot, bred and reared in the north, should yet be able to assume a browner and pinker plumage than its parents, although in Arctic regions. The explanation may, however, possibly be due to the fact that when the old birds moult they have had a long journey immediately followed by the strain of the breeding season, compressed into the short Arctic summer, so that we would expect their vigour in autumn to be very low; whereas, on the other hand, the young bird has only had to grow, which is probably a far less strain on its system than that undergone by the parents. The result is that the young are enabled, although in Arctic regions,* to assume, to a slight extent, a colour belonging rather to the tropics.

This case is, to my mind, of considerable importance as showing that "colour" is dependent far more on "vigour" than on the particular latitude in which it is produced.

Knots, when kept in captivity, rarely, if ever, assume the full deep chestnut which they do when wild, the amount of change depending largely upon the individual. For two winters I endeavoured, by keeping these birds at a fairly high temperature, to induce them to assume their full red colour, but it produced no appreciable effect, showing, therefore, that heat has, in this species at all events, but little power.

The golden plover at first sight offers rather a puzzle, for in this species the birds, which nest in the southern limit of its range, are duller and in less perfect plumage than those to the north, which is apparently exactly the reverse of what ought to take place. It has, however, been proved for some species of birds, *e.g.*, *Geothlypis*, that those individuals of a species that breed the furthest north, winter furthest south, and, consequently, the full plumaged golden plovers that breed in the far north may presumably have wintered in the tropics, while those that breed with us have never entered the torrid zone.

Further evidence in support of this suggestion is given by that nearly-allied species, the grey plover, whose breeding range is entirely in the north, and that only occurs in the temperate zone on migration, for in this species all individuals assume their full summer dress.

To take a further example. The ducks may be roughly divided into two groups :—

(1.) Those in which the male assumes a dull plumage after the breeding season. (Restricted entirely to those species in which the sexes are markedly distinct.)

(2.) Those in which the male and female are similarly coloured. (Chiefly found in the tropics.)

Of this latter group, the long-tailed duck (*Harelda glacialis*) is the *only* species which occurs in Arctic regions.

This bird, moreover, differs in its plumage from all other members of the Anatidæ by the fact that there is a summer and winter plumage common to both sexes. According to our present theory, this is quite easy of explanation. The light-coloured winter plumage is assumed in Arctic regions after the breeding season ; the winter is spent in temperate regions, and the summer plumage produced there (under conditions which must be very mild to an Arctic species) is brown.

## II.—THE TROPICAL REGIONS.

Leaving the Polar regions, where the contrasts of the seasons are greatest, let us now turn to the tropics, where the contrasts are least.

In the first place, the conditions are such that life can be carried on in a high state of "vigour" during all seasons of the year, and abundance of food in the shape of fruit and insects may be had in every month, the only seasonal differences being those of wet and dry.

Although these naturally have a considerable effect in

* It has been pointed out to me that some birds migrate in autumn before they moult, which is sometimes undoubtedly the case, although I believe that in the majority of instances this is due to their being driven south by early storms before the moult has been completed. In any case the moult would follow so soon after migration that their system would not have had time to respond to the more generous influences of a southern clime.

† For further suggestion on this point see *P.Z.S.* 1901, p. 325.

* Of course the tendency of the species to assume red must be taken into account, as it causes the bird to be pink instead of brown on the breast, though the brown colour appears on the back. As I previously pointed out (*loc. cit. ante*), the red plumage is in this case probably the older plumage.

determining the breeding seasons of many species of mammals and birds, yet the periods of drought and wet are so local, and determined to such an extent by the geographical conditions of the country, that they need not be considered in a paper dealing with the subject so broadly as the present one.

We are, therefore, not likely to find in the tropics great differences of colour, since any climatic change that may exist will tend not to coincide with the breeding season, and the latter will be spread over the greater part of the year.

From these reasons, therefore, it will be evident that the life of an animal will run much more evenly so far as its metabolism is concerned, and, food and temperature being favourable to a high state of vigour, we should expect to find animals deeply coloured and remaining so throughout the year.

Some animals, however, will be so weak that they can only exist where the conditions of life are most favourable, so that, although living in the tropics, their vigour will be low. Such animals, therefore, according to my argument, should be white or pale coloured, and restricted to the tropics, while the brighter-coloured tropical animals should be found to have a much wider range, the majority decreasing in colour as they spread north or south.

Of these brighter animals the tiger and leopard afford good examples. The buffalo of India is black, but in Assam a light variety is found, and the more northern species of Bos are found to be lighter in colour. The squirrels, another brightly-coloured group, are, like the oxen, cosmopolitan, shading through brown to grey in the northern regions.

White or grey tropical mammals are very scarce, but we may notice the bamboo rat (*Rhizomys sumatrensis*), which is dirty white in colour and does not range north of Burmah. *R. pruinosus*, a rather darker species, ranges as far north as Assam, while *R. badius* and *R. sinensis*, both dark brown species, range from the south as far north as Bhutan, Nepal, and even Thibet.

As regards the birds, we may notice the kingfishers and rollers, typical tropical families, which range to more northern climates.

The parrots, which by the same process of reasoning one would expect to find in more temperate zones, only extend to a limited extent. This is probably due to two causes :—

(1.) Their sedentary habits.

(2.) The fact that many of them are not as brightly pigmented as they appear on the surface, the predominating pigment being yellow.

On the other hand, many of them are perfectly hardy, and stand our climate out of doors well, so that probably their sedentary habits have been no small factor in restricting their range. Humming birds also range far to the north, but have to retreat before the winter, probably from lack of food, while the sunbirds of India are probably restricted by the Himalayas. The *Phasianidæ* are another example of bright-coloured tropical groups extending northwards.

Dull-coloured tropical birds (not counting those from temperate regions that have migrated to the tropics) are not numerous.

The hoatzin (*Opisthocomus*) is, however, a good example of a dull-coloured tropical bird, which, as we might expect, we find restricted to the tropics, while the bell birds (*Chiasmorhynchus*) form another good example.

(*Continued.*)

# The Venom of Spiders.

By C. AINSWORTH MITCHELL, B.A. (OXON.), F.I.C.

(*Continued from page* 299.)

The modern conception of toxines is based on Ehrlich's "side-chain" theory, according to which a toxine is a very unstable body, whose molecule may be represented as containing different unsaturated groups. One of these is termed the *haptophore* group, and it is that which combines with corresponding groups (*receptors*) in the attacked cells and enables the active or *toxophore* group to do its work. If there are no corresponding groups in the blood of the animal the toxine simply circulates inertly and finally disappears. A striking instance of this is seen in the effect of tetanus (lock-jaw) poison upon the alligator, for although the reptile itself is proof against the action of tetanus, its blood becomes toxic and will infect a susceptible animal, i.e., one whose blood contains suitable receptors for the toxine.

In like manner the hedgehog is refractory to snake venom, and also to spider venom, and its partial insusceptibility must be attributed to a lack of receptors, for the blood of a hedgehog that has been bitten becomes highly venomous.

It is further assumed in Ehrlich's theory that "side chains" are generated within the animal, to replace those of the cells fixed by the toxine, and these, being formed in excess, circulate in a free state in the blood and form the specific immune substance or antitoxine.

Now, spider venom answers all the requirements of a toxine, as defined by Dr. Ehrlich. It is unstable, and produces an antitoxine which is capable of neutralising its action when mixed with it in the right proportion. It resembles snake venom in possessing more than one active principle. In snake venom there is one toxine which acts upon the nervous system, a second acting upon the cell walls, and a third, termed a *hæmolysine*, which dissolves the corpuscles of the blood. Similarly, in spider venom there is one active principle, which acts upon the nervous system and heart, and another, a hæmolysine, with a solvent action upon the red blood corpuscles.

This hæmolysine has recently been separated from the common garden spider by Dr. Sachs, who terms it *arachnolysine*. It has a very energetic action upon washed blood corpuscles. Those of the rabbit, rat, and mouse are rapidly dissolved, while human blood corpuscles are less susceptible, and those of the guinea pig, sheep, horse and ox absolutely refractory. The blood corpuscles of young chickens are at first quite refractory, evidently from a lack of *receptors* to combine with the *haptophore* group of the toxine, but as the bird grows older its corpuscles become more susceptible, until after about a month they attain the normal susceptibility of the hen. Dr. Sachs also succeeded in producing an antitoxine, *anti-arachnolysine*, to this toxine by inoculating animals with gradually increasing doses. The serum of the animal thus immunised was very active, and when mixed with freshly extracted venom neutralised both its toxic and its hæmolytic action.

There is thus no doubt about the existence of powerful toxines in the various species of lathrodectes and in the garden spider, and possibly in *Chiracanthium nutrix*, a South European species, and the reason why the bite of these is sometimes insignificant is that the

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quantity of venom injected is then too small to be effective.

The bite of the tarantula, *Lycosa tarantula*, the fierce-looking spider which is very common near Taranto (whence its name), was at one time much more dreaded than that of the malmignatte, and is particularly interesting from having been associated with that curious mental state known as *tarantism*, and its reputed cure by music.

This is described by Ferrantro Imperato, in a Natural History published in Naples after his death, in 1599, and the details he gives are amplified by subsequent writers in the early part of the 17th century.

In the Philosophical Transactions for 1671 (Vol. VI., p. 3002) we find an enquiry from Marten Lyster "as to the truth that a person bitten by a Tarantula be not ever when on his feet disposed to and actually dancing after the nature of a Tarantula, which never moves but by skippings. And if so, what are we to think and credit concerning such and such musical tunes said to be most agreeable and lending to cure of persons bit by a Tarantula?"

Robert Boyle also made enquiries from friends in Taranto, and was convinced of the truth of this music cure, which he ascribed to sympathetic vibrations in the patient (*Essay of the Great Effects of Motion*, 1690, p. 74) :—"But the Eminentest Instance of the Efficacy of peculiarly modified Sounds is afforded by what happens to those that are bit by a Tarantula. For though the bitten person will calmly hear divers other Tunes, yet when a peculiarly congruous one comes to be plaid, it will set him a dancing with so much vigour as the Spectators cannot but wonder at, and the dancing will sometimes continue many hours if the Musick do so, but not otherwise."

Richard Mead, Physician to the King, published in 1745 a *Mechanical Account of Poisons*, in which one of the sections is devoted to the Tarantula. He describes various symptoms and asserts that "that the patient being asked what the ail is, makes no reply, or with a querulous voice and melancholy look points to his breast, as if the heart was most affected." He also describes the dancing cure at length :—"While the Tarantati are dancing they lose in a manner the use of all senses, like to so many drunkards, do many ridiculous and foolish tricks, talk and act obscenely and rudely, take great pleasure in playing with vine leaves, with naked swords, red cloths, and the like ; and on the other hand can't bear the sight of anything black; so that if any bystander happen to appear in that colour, he must immediately withdraw, otherwise they relapse into their symptoms with as much violence as ever."

All kinds of fables were believed. It was asserted that the patient was only affected so long as the tarantula lived, that the spider itself danced to the same tune that cured the patient, and that each one had its own specific tune. "This curious frenzy of dancing was infectious, and even those who had not had the mental excitement of the Tarantula's bite joined in as madly as the patient. The disease was said to recur every year at the same time and to be cured again by the same music."

At the time that Robert Boyle made his enquiries, this epidemic of dancing was at its height, but even then experiments had been made to prove that the bite of the tarantula was not the cause of the mania. Dr. Sanguinetti, of Naples (1693), made two Tarantulas bite him upon the finger and found that the bite had no more effect than the sting of an ant ; and his experiments were repeated by Dr. Serrao, in 1748, who concluded that the bite never produced serious results, and that music had nothing to do with the tarantula.

A letter from Dr. Domenico Cirillo, Professor of Natural History at Naples, is published in the Transactions of the Royal Society for 1770, in which he stated that there was absolutely no truth in the surprising cure of the bite of the tarantula. He asserted that each year the disorder lost ground, and that he was confident that in a little while it would lose its credit.

There are numerous other accounts extant, showing that the bite of the tarantula is not dangerous, either to man or to cattle, and these are fully supported by the fact that Dr. Kobert found the extracts from tarantulas to be quite harmless.

The only relic that now survives of the old dancing mania is in the name of the dance of Southern Italy, the *tarantella*, which, according to an old authority, was one of the dances of the *tarantati*.

Similar dancing epidemics have been known in other parts of Europe, notably during the 14th century, in the Rhine and Moselle districts, where men and women, old and young, danced from town to town, dancing in the streets, in the squares, and in the churches—everywhere.

As regards the Italian epidemics, there were probably cases in which the effects of the bite of a malmignatte were attributed to the tarantula, but in most instances fear was probably the main cause of the illness, and produced a state of hysteria, which found its expression in violent and uncontrolled dancing.

# Scientific Sewage Treatment.

## The Leek Sewage Farm.

IN Slater's book on "Sewage Treatment," published in the year 1888, there is the following passage :—

"Unfortunately there is no subject, outside the range of party politics, on which so much envy, hatred, malice, and all uncharitableness prevail as on the treatment of sewage."

The history of the many abortive attempts which have been made to deal in a satisfactory manner with sewage purification, together with the magnitude of the interests involved and the curious vested interests which have grown up, explain the generation of the atmosphere of prejudice, through which all efforts at improvement are looked down upon.

It has not in the least degree surprised the writer of this notice that, although the first sketch of the new method of treatment dates back to the year 1899, the first opportunity of practical application on the large scale did not arise before the year 1903, when the waterlogged condition of the Leek Sewage Farm and the evils attendant on that condition provided the opportunity.

At the beginning of the year 1903 the sewage from a population of 8,000 persons, together with refuse from various manufactures, had been discharged upon the Sewage Farm during several years, and at the lower part of the farm a large tract of land was actually under water, which covered a deep layer of black sewage mud. Every day matters were becoming worse, and the necessity had arisen to stop the flow of sewage,

or, indeed, of liquid of any kind on to the farm. So desperate had the situation become that instead of allowing the fetid swamp to increase the Leek authorities might have been obliged to send the raw sewage down the storm overflow into the river and to continue doing so until a partial recovery of the farm had taken place.

Under these conditions a chance was offered for the introduction of the new and untried process. The tanks which received the sewage on its arrival at the farm were so small that none of the common processes of precipitation were applicable, but they were quite large enough to admit of excellent work being accomplished by the new process.

The installation of the new process was quickly accomplished, viz., in three weeks, and the cost was insignificant.

On April 3, 1903, the sewage began to flow into the first aerater charged with wood charcoal. On April 11, 1903, the discharge of liquid on to the sewage farm was stopped. Instead of the liquid being run from the tanks on to the surface of the farm and then left to percolate through the land, the liquid was provided with a connecting channel so that it might pass from the upper distributing system of channels into the lower collecting system and into the river without deluging the land.

Under the new order of things the Leek Sewage Farm recovered rapidly, the fetid marsh dried up and was ploughed and became cultivated land. The flourishing condition of the vegetables on the farm attracted public attention as the summer advanced, and there was a prospect of making a profitable employment of sewage.

The quality of the liquid discharged by the Leek Sewers is most variable, and the rate of flow irregular. The Leek water supply contains very little foreign material of any kind, the total solid residue amounting to only six grains per gallon. On Sundays when the sewers do not carry manufacturing refuse, the sewage contains about 60 grains per gallon, some of which is suspended matter, the rest being dissolved matter. The week-day sewage is very different. An average sample, taken on Wednesday, August 12, 1903, was very carefully analysed by the writer with the following results :—

Specific Gravity 1001.6.

One Gallon contained :—

| | Grains. |
|---|---|
| Organic Matter .. .. .. .. | 35·0 |
| Soda $Na_2O$ .. .. .. .. .. | 33·0 |
| Silica Si Oz .. .. .. .. .. | 13·0 |
| Alumina and Oxide of Iron .. .. | 6·3 |
| Lime Ca O .. .. .. .. .. | 3·5 |
| Chlorine .. .. .. .. | 8·8 |
| Undetermined .. .. .. .. | 12·4 |
| Total solid residue .. .. | 112·0 |

The immediate effect of the treatment with charcoal and the action of the aerater was to reduce the solid contents to 90.3 grains per gallon ; and there was a further reduction to 66.0 grains when the effluent was allowed to deposit its suspended matter.

The importance of these results depends upon the care which was taken to ensure that the samples of sewage and sewage-effluent were true average samples and were strictly comparable with one another. They were the official samples collected by Mr. Farrow, the Sanitary Inspector, whose trustworthiness and accuracy in matters of this description are proverbial in Leek. Beginning at nine o'clock on the morning of August 12, 1903, Mr. Farrow collected a sample once in the hour and continued the work of collection until five o'clock in the afternoon. The nine samples were mixed together so as to form the average sample of the week-day sewage, which was sent to the writer's laboratory by the Sanitary Authority of Leek. In like manner the effluent collected just as the liquid issued from the two small tanks was obtained by Mr. Farrow and sent to the writer's laboratory.

The rate of flow through the two small tanks which had been converted into aeraters and charged with wood charcoal was about two-hours ; that is to say, each gallon of sewage issued from the tanks in the condition of sewage-effluent two hours after it had entered the tanks in the condition of raw sewage.

The alteration in the composition of the sewage during its two hours' sojourn in the tanks and its conversion into sewage-effluent is expressed as follows :—

| | Raw Sewage. | Tank Effluent. |
|---|---|---|
| Specific Gravity .. | 1001·06 .. | 1000·82 |
| Total solid contents grains per gallon | 112·0 .. | 90·3 |

The removal of the 21.7 grains corresponds fairly well with the diminution of density. The tank-effluent was turbid, and on keeping at rest for a period, and afterwards subjecting it to careful decantation it lost 24.3 grains of solid contents, the total solids per gallon having fallen to 66 grains.

On August 12 when the average samples were collected by Mr. Farrow, the connecting channel was not in use, and it was therefore impossible to collect a sample of liquid at the outfall into the Churnet which would exhibit the degree of purification attainable in the channels in the absence of land treatment.

In the next month, viz., on September 9 and 10, the connecting channel was brought into play, and after a twenty-four hours' employment of that channel a sample of effluent was collected at the outfall into the Churnet. The total solid contents was found to be 67.3 grains per gallon.

Under the actual circumstances prevailing at the Leek sewage farm these diminutions in the total solid contents of the liquids afford a most satisfactory proof of the accomplishment of the purification. The substances employed in bringing about this purification are atmospheric oxygen, water, and wood charcoal. The purification begins in the two small tanks, and goes on in the long channels (a third of a mile in length) which intervene between the tanks and the river Churnet.

The writer of this notice was present when, on April 3, 1903, the raw sewage, laden with a forty-eight hours' accumulation of solid excrement, was suddenly turned into the left-hand tank (which had been fitted up with the proper partitions and the requisite charcoal), and he can vouch for the instantaneous and complete success of the arrangements. Standing close to the tank he noted that there was no fetid smell whatever, but only a slight odour of soapsuds. Properly applied wood charcoal is, indeed, a most potent sanitary agent ; and the reintroduction of this agent into the working of sewage farms marks the beginning of a new era in sewage-purification.

In the year 1903 the writer spent 78 days in Leek and watched over the operation of the new system at the sewage farm. His last visit to Leek was on May 2, 1904. Up to that day (being a period of 13 calendar months) the new system was in operation in Leek, and the writer is now in a position to give an estimate of the consumption of charcoal. It is at the rate of one ton per thousand persons per annum.

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# The Disintegration of Saturn's Ring System.

By W. J. KNIGHT, LL.D.

IN his standard work on "Saturn and its System," Mr. R. A. Proctor has so lucidly and convincingly discussed the disintegration of the rings of Saturn and the consequent and recent formation of the dark ring that subsequent research has done little more than ratify the conclusions at which he arrived. It is therefore to be regretted that he has not extended his investigations to the phenomena of the outer edge of the outer ring, where problems of great beauty present themselves for our consideration.

Mr. Proctor remarks that the exterior diameter of the outer bright ring has not perceptibly increased, and suggests a resisting medium as the reason why. I would, with all respect, prefer to think of the accelerated satelloids, at the outer edge, being thrown off bodily, like fragments from the rim of a rapidly revolving grindstone. The subsequent fate of such a satelloid is full of interest. The path it would describe would be that due to the resultant of the three forces acting on it at the moment it started on its separate career, viz., the force producing its orbital motion, in conjunction with Saturn round the Sun; the force inducing rotation around its primary, and the force of impact. This path would lie in a plane but little inclined to the plane of the rings, but might have any direction in that plane, depending on its instantaneous path at the moment when it left the ring. Dismissing from our consideration all but those trending sunwards, let us follow these tiny planetoids as they trace out their spiral orbits towards the sun. At first invisible, owing to their small size and great distance, the larger ones become perceptible, when, in the absence of The Giant Planet, they succeed in crossing the orbit of Jupiter and are registered in our catalogues as The Planetoids, Ceres, Pallas, Juno, Vesta, with hundreds of others of kindred origin. All, however, are not so successful. Attempting the passage near Jupiter itself, the influence of its mighty mass is sufficient to tear them from their independent orbits and to compel them to assume the subordinate positions of satellites of Jove. The motions of these satellites is direct if they are arrested whilst crossing in front of Jupiter, but retrograde if behind. Possibly the Great Red Spot indicates the fate of one which actually collided with Jupiter itself. After passing the orbit of Jupiter, the track of the planetoids was clear until they approached the orbit of Mars, which they appear to have done quite recently, two, Phobos and Deimos, assuming the *rôle* of Marsian Moons, and one, Eras, passing within that orbit and holding out to terrestrial observers the possible acquisition of a second Moon by the Earth itself.

As a confirmation of our theory, it should be observed that the orbits of all the planetoids have but a small inclination to the plane of the rings, but we have yet to assign the causes, both of the disintegration of the rings and of the spiral form of the planetoidal orbits. We take these in order. Saturn, though probably the hottest planet of our system, is yet a cooling body, and the rings, from their extreme thinness and great extent of surface, are cooling much faster than the planet. What wonder then, since the rigours of an arctic winter can split up the crystalline rocks of Spitzbergen, though shielded by the earth's atmosphere—what wonder that the fearful cold of interstellar space should crumble up the rings of Saturn? The wonder would be if it did not. Here, then, we have a simple but adequate explanation of this phenomenon. Let us now investigate the form of the orbits of the satelloids after assuming an independent existence. We shall best do so by making our observations from the sun, at a time when the plane of the rings passes through it. A straight line joining the centres of sun and planet would then cut the outer edge of the outer ring in a point occupied by a satelloid, which we will call "Quesita." Just prior to impact, the whole saturnian system is moving eastward with a velocity just sufficient to counterbalance the attraction of the sun, but, as Quesita is in inferior conjunction with Saturn, it appears to lag behind the planet in its eastward course, and if now it receives an impact from a following satelloid, it is detached from the ring, is abandoned by Saturn, and left, with diminished velocity, to pursue its eastward path alone. But, as its velocity *before* impact was only just enough to balance the attraction of the sun, its velocity *after* impact is insufficient for that purpose, and so Quesita is drawn sunwards. The amount of this disturbance may be small at first, but, as there is no force to increase the orbital velocity of Quesita, and as the sun's attraction increases as the inverse square of the distance, the planetoid is continually deflected from its instantaneous orbit and forced to describe a spiral curve, at first differing little from its original ellipse, but becoming more and more inclined to it as the years roll on, until it will finally terminate in the sun itself, just as the spiral orbits of the satelloids of the Crape Ring are rapidly approaching the body of the planet. As a further corroboration of our theory, it may be noted that recent observations have shown the necessity of applying "corrections" to the elements of Ceres, Pallas, Juno and Vesta. These corrections being required, not because the former observations were faulty, but because, being applied to an elliptic orbit, they failed to give the position of a body really describing a spiral curve. Still, as these helicoids are not greatly different from ellipses through several revolutions of the planetoid, it may be still convenient to calculate their places by means of the approximate ellipse and then apply corrections from time to time.

## CORRESPONDENCE.

### Magnetism of the Sun.

TO THE EDITORS OF "KNOWLEDGE."

SIR,—M. Salet, appointed by the Paris Bureau des Longitudes, to observe the late eclipse, in Algeria, made observations on the magnetic field in the neighbourhood of the sun by observing the amount of deviation in the plane of polarisation of the coronal light. The plane of the bands was found to be deviated in the right-hand direction 2° S. This visual observation was confirmed by photography which showed the plane of polarisation to be almost radial.

The sun, therefore, has very little magnetism.

Magnetisable material can be made a magnet by surrounding it with a belt of electricity; but if completely surrounded by a sphere of electricity there could be no poles and no magnet. This is nearly the case with the sun, the electrical activity of which is nearly equal over its whole surface, and were it not for the slight increase of electricity which pervades the sunspot bands, it would have no magnetic force at all. W. BADGLEY.

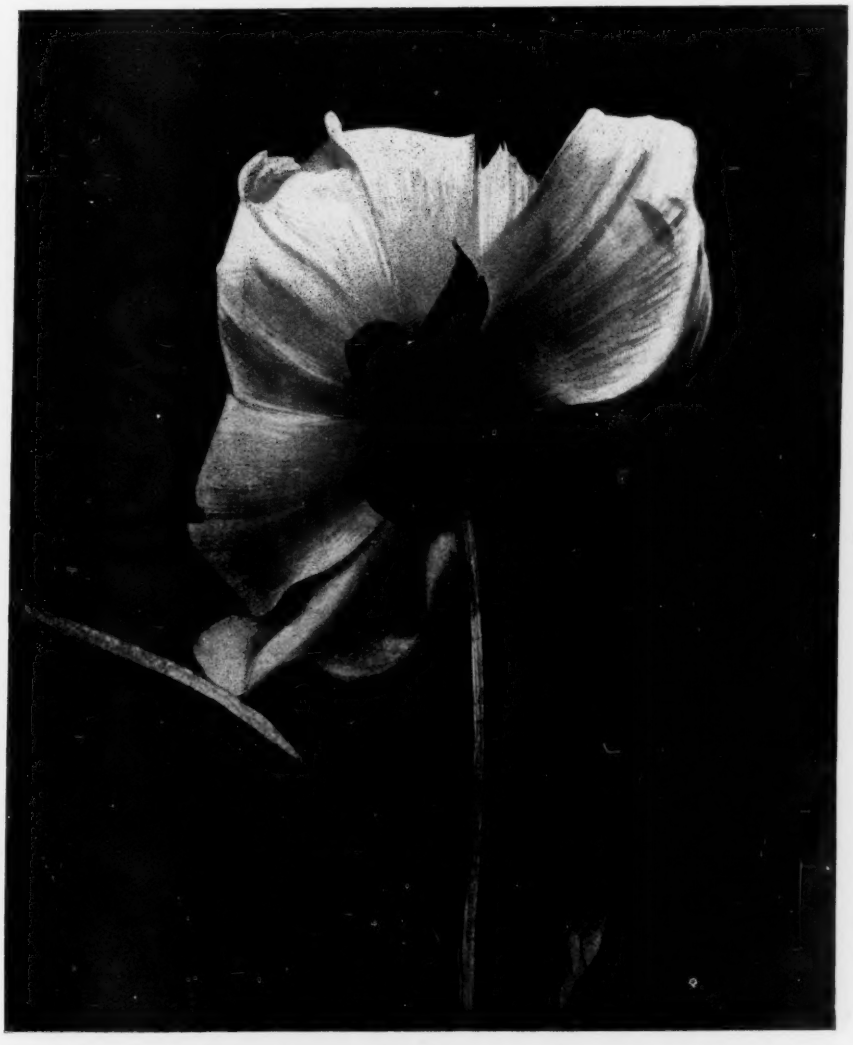
Exmouth, November 24, 1905.

# The Evolution of the Flower.

By S. LEONARD BASTIN.

PART I.

BROADLY speaking, without the complicated system of organs to which, as a whole, we have given the name flower, the blossoming plants could not continue to exist. With certain exceptions all the host of diversely formed plants which produce flowers are solely and entirely dependent upon the offices of the floral organs for the perpetuation of their kind. Some species, it is true, seem to be able to flourish and increase apart from the services of the flower—for a time, at any rate. A notable instance of this may be cited in the case of the Lesser Celandine (*Ranunculus ficaria*), in which plant a great deal of the increase is carried out by means of the small tubers which are to be found thickly clustered round the root stock. Some authorities go so far as to say that the Lesser Celandine only very rarely produces fertile seed. Numerous other kinds of plants are also able to propagate their kind by root increase, runners, and such like methods. But, as any florist is only too well aware, these processes are only really extensions of the original parent, for new *individuals* we must look to the seed. This brings us back to the all-important flower, and it will be the endeavour of the present paper to try to show by means of natural examples in what this indispensable body of organs had its origination.



**THE PÆONY.—In the calyx of this flower, it is often seen that the sepals resemble leaves.**

It may be of interest to refresh the memory regarding the number of parts which go to make up the typical flower. Starting from the outside of the bloom we find the calyx; this consists of a number of sepals which may be green or coloured. Enveloped in the calyx is the corolla formed of a number of petals usually coloured to a greater or less degree. In the centre of the flower we find on the outside a certain number of the pollen-producing stamens, whilst in the middle of

all is the group of carpels which go to make up the pistil. For the present purpose it will be all sufficient to think of the flower as consisting of these four parts—calyx, corolla, stamens, and pistil. As well, in not a few flowers, there are present a number of appendages to which has been given the name bracts.

**MOON DAISIES.—It is interesting to note the manner in which the leaves become more like the bracts as they approach the flower.**

As has been stated, the calyx of the flower is sometimes green and sometimes coloured. This is equivalent to saying that the sepals on occasion produce chlorophyll, and in this condition they, of course, carry on the functions of an ordinary leaf. This being so it is interesting to see whether it is possible to discover any relation between the sepal and the leaf other than the fact that both indicate the presence of chlorophyll. In this connection the case of the ordinary herbaceous Pæony is very noteworthy. If a number of specimens of this flower be examined it will be found that quite often the sepals of the calyx are really modified leaves. Indeed, time and again it is impossible to determine definitely the exact nature of the organs, and the confusion is all the greater when, as is often the case, a large area of the leaf-like sepal is as gaily coloured as a petal.

The common Moon Daisy of the meadows (*Chrysanthemum leucanthemum*) reveals in the nature of its growth the whole course of the evolution of the green bracts which encircle the mass of ray florets. Gather one of the long-stemmed blossoms, taking care to pluck it with as many of the lower leaves attached as possible. Now, starting from the bottom of the stem where there is nothing but the typical well-developed leaves of the species, allow the eye to travel upwards towards the flower head. With every fresh stage in the approach to the top there is a notable decrease in the size of the leaves. Finally they lose their distinctive form altogether, until just below the flower the leaflets drift into simple lobes, which bear a striking resemblance to the green bracts which form such an important part of the flower head.

Numerous instances might be noticed in which it would be clearly seen that we shall not be far wrong in assuming that the green sepals of the calyx are really nothing more than advanced leaves. But these sepals are often as gaily coloured as the petals themselves, being entirely devoid of the green tissue which is present in the leaf. In certain species, such as the Campanulas, the sepals and petals are actually joined together to form one big bell-shaped corolla. Under these circumstances it may not be amiss to consider for the time being both the floral appendages, whether sepals or petals, as one and the same thing.

The common garden Tulip is a well-known example of a flower in which the petals and sepals are identical; at any rate, as far as the ordinary observer can say. Now if we observe a large number of cultivated Tulip blossoms we shall certainly find that in not a few some of the sepals—that is to say, the outside circle of appendages—are partly or wholly green, proving beyond a shadow of a doubt whence they have their origin. This is especially so in the case of double Tulips, and the reason for this is probably owing to the fact that the double flower is a more artificial form of Tulip than is the single variety. It is well known that the more highly cultivated and artificially specialised is a plant the greater is the tendency to variation and reversion to early types. Moreover, in the Tulip, just below the flower a strange leaf-like appendage is often produced, and the intelligent observer will readily see in this a kind of half-way house between the leaf and the sepal.

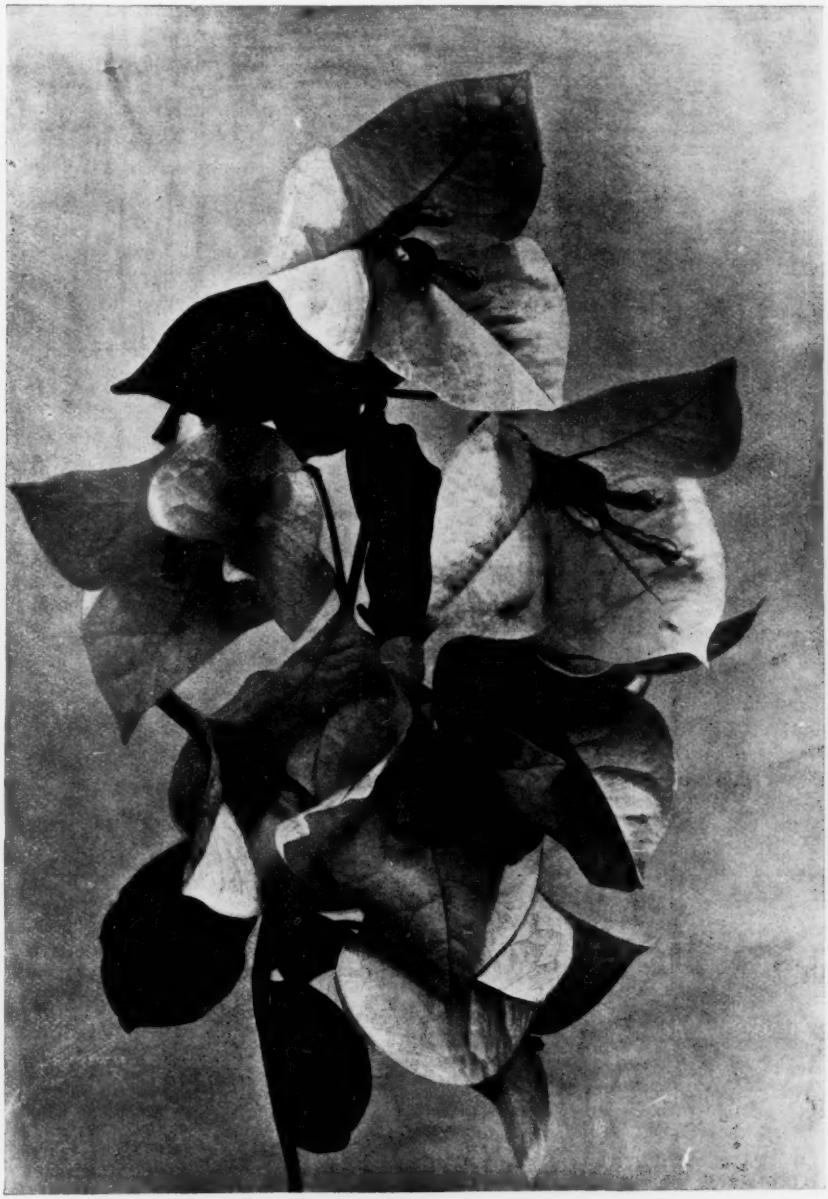
**TULIPS.—In double varieties of this flower the leaf origin of the calyx is very apparent.**

Perhaps a still more striking proof of the leaf origin of both petals and sepals is to be seen in the flower of the Summer Snowflake (*Leucojum æstivum*). Each

portion of the perianth is tipped with a dot of pure green, and this spot stands out in vivid contrast to the snowy whiteness of the rest of the organ. For what special purpose this conspicuous marking of green may have been retained it is not easy to say ; it is all sufficient, however, to show to the student the leaf ancestry of the sepals and petals.

all of a green colour. If examined closely they are seen to be nothing more than diminutive leaves, and they even go so far as to retain the toothed edges which are so familiar a feature of rose foliage.

The change of the leaf into a coloured sepal or petal is not, after all, very remarkable, for coloured leaf-like organs, which really exhibit their character in every



*Bougainvillea glabra.*—**A splendid South American species with showy bracts.**

We can find at least one example belonging to an advanced family which has not found it necessary to produce any coloured sepals or petals for its flowers at all. The Green Rose (*Rosa viridis*), a curious variety of the China Rose, is, as its name suggests, entirely without any coloured blooms. Yet this flower is possessed of a number of sepals and petals, but they are

respect except that they are not green, are not at all uncommon. One of the most striking plants exhibiting this change of colour in the leaf is a South American species, *Bougainvillea glabra*, specimens of which are fairly often grown under glass in this country. The real flower of the *Bougainvillea* is a small yellowish blossom, of a much duller hue and nothing like the

striking appearance of our Cowslip. These are produced in clusters of three, and would scarcely be noticeable amongst the foliage were it not that each cluster of blooms is surrounded by three conspicuous bracts. These bracts are exactly in the form of leaves, but are coloured in a highly attractive tint of bright lilac. Presumably this strange development is to attract the attention of insects, as a Bougainvillea in full bloom is an object which would be conspicuous from a considerable distance. In much the same fashion Brazilian Euphorbia (*Pointsettia pulcherrima*) has been able to call attention to its green flowers by surrounding these with a circle of bracts coloured with the brightest crimson. In each of the cases mentioned above it is impossible for the student to determine definitely whether the bracts may be referred to as leaves or petals.

**THE SUMMER SNOWFLAKE.—In this flower the leaf origin of the petals and sepals is easily discernible, each organ having a green spot.**

A more familiar plant than either of the showy exotics referred to is the *Salvia herminum rubra*, a common garden species. This plant has seen fit to resort to extraordinary means to advertise its small labiate flowers. When the Salvia is in bloom the terminal leaves of each flowering spike are coloured in the brightest pink. That these are true leaves is very evident from the fact that as one proceeds down the stem it is possible to find leaves which are half green and half pink, until one arrives finally at the wholly green leaves.

A further remarkable proof of the fact that the petals and sepals of the flower have their origin in the leaf is to be seen in the case of such a species as the Christmas Rose. This plant, as is well known, produces white blossoms during the winter time. What one may call the corolla of this flower is peculiarly tenacious in retaining its position on the stem, even after the essential organs of the flower are past their maturity. This corolla is really made up of petal-like sepals, the real petals being small processes scarcely distinguishable from the stamens of the flower. But the curious part about these white sepals is the fact that when the flower is "over" they do not fade away as one might expect, but gradually lose their whiteness and eventually become green and leaf-like in appearance. Much the same process goes on in the case of the Hydrangea and its showy bracts. Of course, it is well known that the attractive part of the Hydrangea heads of bloom are merely showily coloured bracts surrounding inconspicuous flowers. These bracts remain long after the real flowers have faded, and gradually lose their colour, finally becoming as green as the leaves of the plant itself.

Moreover, there are many species of plants in which the coloured parts of the flowers gradually develop from very green material. This is seen in the case of some of the Guelder Roses (*Viburnum*). As a matter of fact, in many species the undeveloped sepals and petals practically perform the offices of leaves during the early stages of their existence.

Numerous instances might be cited in support of the examples given above, but these would be little more than a reiteration of similar facts. Regarding the evolution of the sepals and petals of the flower from the leaf the case is surely a proven one beyond all doubt.

*(To be continued.)*

# Star Map.—No. 7.

## Virgo, Corvus, Centaurus.

THE important features included in this map are the first magnitude star Spica and the Southern Cross. The objects of special interest are not numerous.

27 *Hydræ* (X h. 20 m. – 18°). A planetary nebula. Spectrum gaseous.

$\gamma$ *Virginis* (XII h. 37 m. – 0° 56′). A binary, distance apart 5″·74.

$\alpha$ *Virginis* (*Spica*) (XIII h. 20 m. – 10° 40′); 1·2 magnitude. Shown, by the movement to and fro of the lines of the spectrum, to be a binary with a small or feebly luminous companion.

$\omega$ *Centauri* (XIII h. 21 m. – 46° 57′). A fine star cluster, visible as a hazy object to the naked eye. Contains some 6000 stars, of which 125 are proved to be variables.

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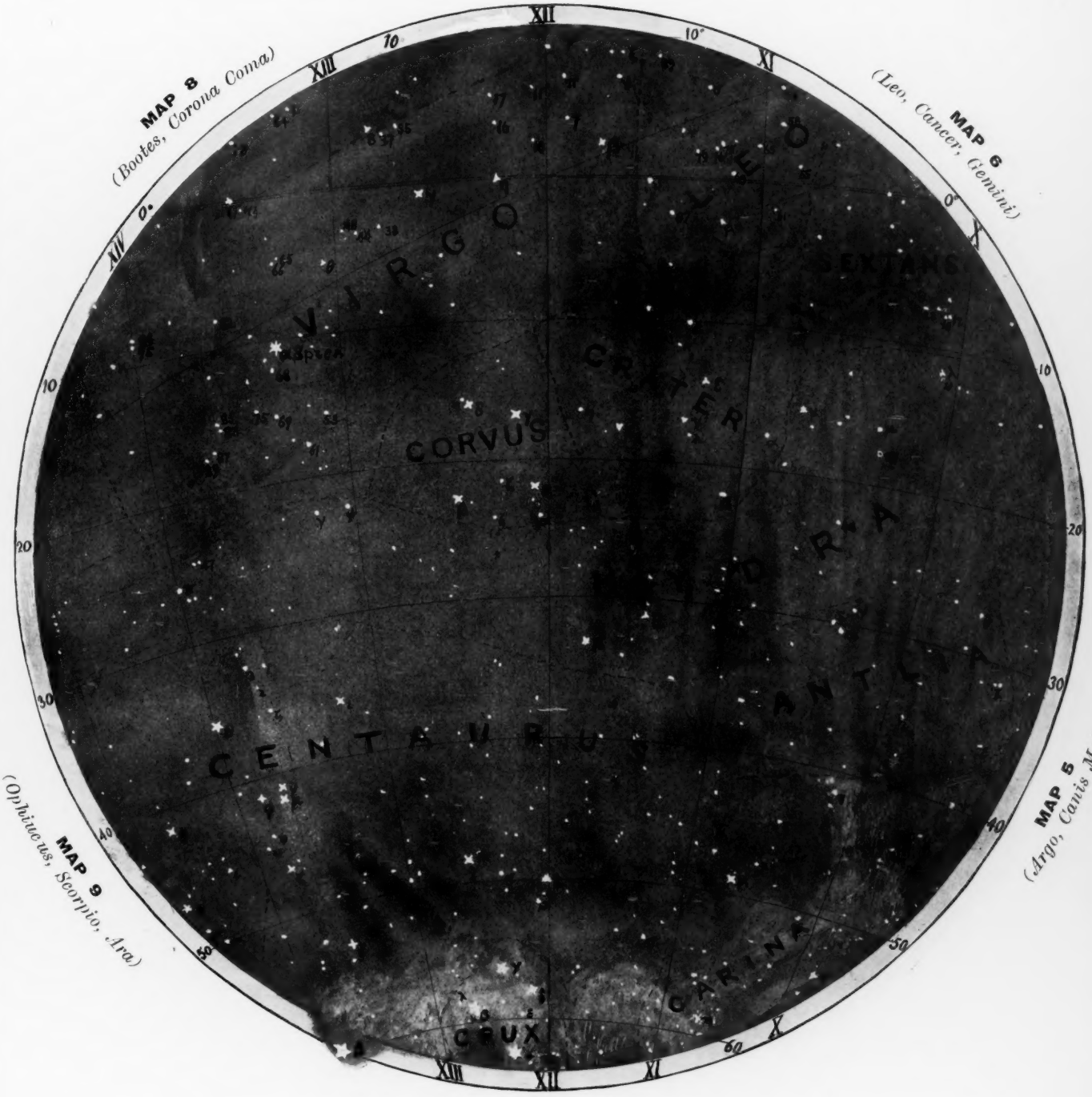
The following are the Lecture Arrangements at the Royal Institution, before Easter:—A Christmas Course of Six Illustrated Lectures, adapted to a Juvenile Auditory, by Professor H. H. Turner, on "Astronomy." Professor E. H. Parker, Three Lectures on Impressions of Travel in China and the Far East; Professor William Stirling, Six Lectures on Physiology Subject; Dr. J. E. Marr, Three Lectures on the Influence of Geology on Scenery (the Tyndall Lectures); Rev. Canon Beeching, Two Lectures on Shakespeare; Mr. Benjamin Kidd, Two Lectures on the Significance of the Future in the Theory of Evolution; Mr. H. B. Irving, Two Lectures on the English Stage in the Eighteenth Century; Mr. Francis Darwin, Three Lectures on the Physiology of Plants; Professor B. Hopkinson, Three Lectures on Internal Combustion Engines (with Experimental Illustrations); Mr. J. E. C. Bodley, Two Lectures on the Church in France; Mr. J. W. Gordon, Two Lectures on Advances in Microscopy; Mr. M. H. Spielmann, Two Lectures on George Frederick Watts as a Portrait Painter; and Professor J. J. Thomson, Six Lectures on the Corpuscular Theory of Matter. The Friday Evening Meetings will commence on January 19, when Professor J. J. Thomson will deliver a Discourse on Some Applications of the Theory of Electric Discharge to Spectroscopy. Succeeding Discourses will probably be given by Professor S. P. Thompson, Mr. H. F. Newall, Mr. W. C. D. Whetham, Dr. R. Caton, Dr. Hutchison, Sir Andrew Noble, Bart., Professor P. Zeemann, Mr. W. B. Hardy, and other gentlemen.

**MAP No. 7.**




BRIGHTNESS.

- 1st Mag.
- 2nd ,,
- 3rd ,,
- 4th ,,
- 5th ,,
- 6th ,,
- Variable
- Nebula.

## MAP No. 7.

### Virgo, Corvus, Centaurus.

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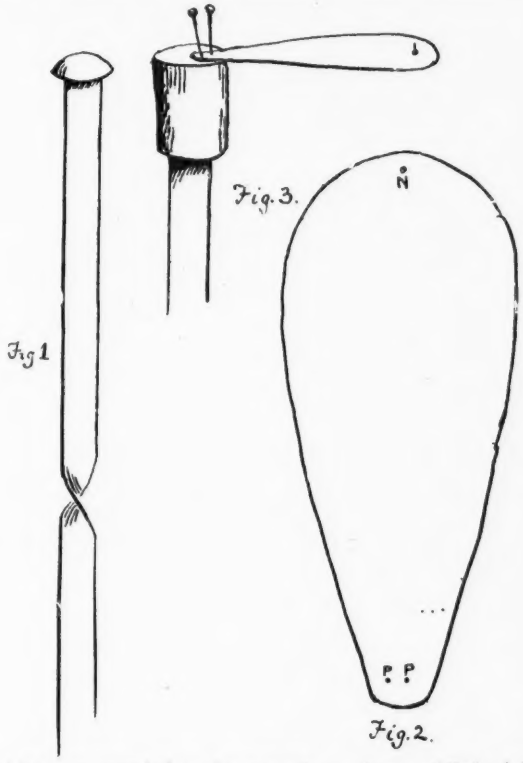
# A Simple Harmonograph.

By CHARLES E. BENHAM.

THERE is a well-known modification of Wheatstone's Kaleidophone, in the form of a piece of clock spring, twisted so that it is divided into two sections, the flat surfaces of which are at right angles to each other. A bright bead is affixed to the top, and the spring is held firmly in a vice. (Fig. 1.) When thus gripped at appropriate places the two planes of the twisted spring, being at right angles to each other, communicate to the bead when they vibrate harmonious curve movements,



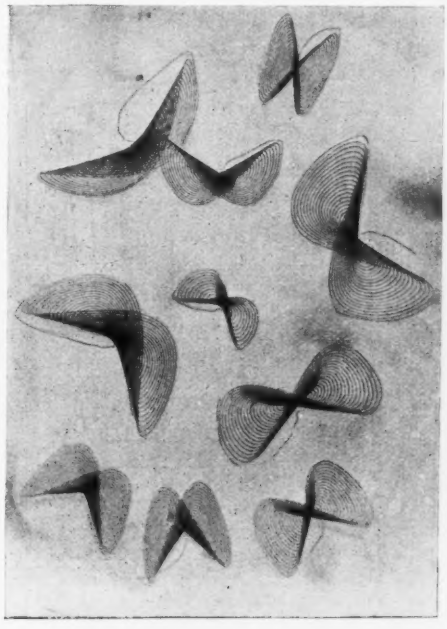

which are revealed to the eye when a beam of light falls on the bead, the reflected point of light becoming by the persistence of vision a luminous track.

Hitherto, however, no attempt appears to have been made to render this simple harmonograph self-recording. The luminous track has, indeed, been photographed, but the trouble involved makes it hardly worth while to adopt this method of registering the curves. As a matter of fact, it is an extremely simple thing to make the spring record its own movements either with a light glass pen, or with a fine point on a smoked surface.

If in place of the bead in Fig. 1 the spring were surmounted by a flat top, it is clear that a lever pen, resting on that surface, would describe the curves there, but the difficulty would be to make the pen rest lightly enough to avoid disturbing the movement, and yet rest firmly enough not to bounce with the rapid vibration.

Such a lever is, however, quite practicable, and it will be found most satisfactory to attach it to the spring itself, the recording being done on a stationary surface.

In place of the bead a cork is affixed quite firmly to the head of the spring, and to the flat upper surface of the cork is affixed by two pins a pear-shaped piece of paper of the shape and size shown in Fig. 2. The paper must be fairly stiff; ordinary writing paper of good quality answers as well as anything, and it is important to preserve the cut-out piece free from bends or creases in any part. The narrow end is attached to the cork, and near the other end a very fine needle point, about half an inch in length, is passed through the paper vertically so that the point projects about one-eighth of an inch beyond the lower surface. The top of the needle point should have been previously warmed and headed with a drop of sealing wax, and when the needle has been inserted in position a lighted match applied near the sealing wax head will cause the wax to melt and run down the needle to the paper, thus cementing the needle firmly in position. The paper lever, with the



**Harmony 1 : 2.**

point at one end and the pins affixing it to the cork at the other, is shown in Fig. 3. It should project with a slight curvature from its own weight, and the smoked glass on which the point is to work is supported on a retort stand or in any convenient way so that the height can be adjusted as required. When thus supported the paper strip should stand horizontal.

This delicate recorder, while firm enough for the purpose required, is sufficiently light and unresisting to register without seriously impeding the movements of the spring, and with careful manipulation it is free from any tendency to rebound.

The smoked surface for the tracings may be a cleaned plate of glass which has been flooded with benzoline and drained at the corner, taking care, of course, not to bring the benzoline can near the flame. It should be smoked with a quick movement in the flame of a candle, not too heavily, but until the surface presents a uniform darkened coating of carbon. This film, being very slightly adherent to the glass, will take the finest lines and there will be no undue friction. An enamelled sur-

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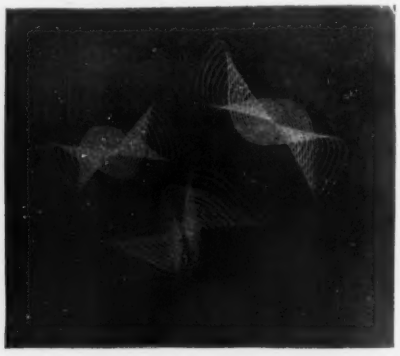
face card may also be used, smoked in the candle flame, taking care to keep it moving so that the surface is not actually burned. The card or glass is laid on a small flat board, supported on the ring of a retort stand or other convenient adjustable support, so that it can be raised exactly to the height of the recording needle.

The spring having been fixed in the vice so that it is



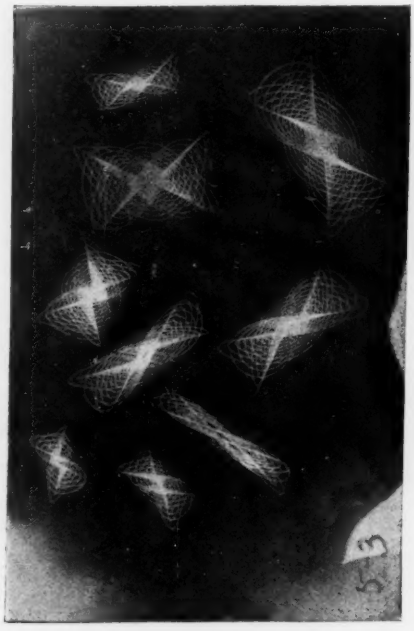
Harmony 1 : 3.

in tune, *i.e.*, so that when vibrated the light on the pin heads shows a curve of harmony, retaining its initial phase, the end of the paper strip near the pen is lifted with the tip of a paper knife so that it is just above the paper, and, keeping it thus supported, the spring is drawn gently in a diagonal direction and released, the paper knife being withdrawn at the same moment and

Harmony 1 : 4.

the curve of harmony is described on the smoked surface with almost magical rapidity. The paper strip must be lifted always by the extreme end and never unnecessarily high, or the "spring" of the paper may gradually be modified and the needle will not fall properly. The same thing may occur if the strip becomes bent or creased, but with moderate care these dangers are easily avoided. Harmonies from four to one downwards may be obtained from one and the same piece of spring by gripping it at different intervals in the vice. Unison and approximate unison figures are obtainable with a straight wire in place of the twisted spring.

Great accuracy is desirable in ensuring a perfect harmony. The curve shown by the bright pin heads should, in a harmony, retain its phase throughout the movement as nearly as possible, and it will be found that a very little movement up or down of the spring is sufficient to throw it into discord or bring it into harmony as the case may be. The harmony should, of course, be secured with the lever in position working upon plain glass or paper, as the weight of the pins and paper strip has to be taken into account. The different phases of the same figure are rendered by the different directions in which the spring is started. When once



Harmony 3 : 8.

the various harmonies have been found they may be conveniently marked in ink on the spring by a line at the position where it has to be held by the vice. The length of the spring above and below the twist will, of course, depend upon the size of the spring. An ordinary piece of clock spring of about twelve inches length twisted at the middle will be found to answer.

The smoked tracings may be fixed by pouring a thin spirit varnish, much diluted with spirit, over the surface, and the glass tracings thus varnished can be used as negatives to print from photographically.

To execute the tracings in ink a fine capillary tube is substituted for the needle. It is made in the same way as the ordinary harmonograph glass pen, by drawing the tube to a point, sealing and grinding down till the hole is reached; but only the tip of such a pen must be used, so that after it has been made the end must be cut off—about half an inch, and this is fixed with sealing wax through a hole in the paper strip in place of the needle. A tiny piece of cotton wool or worsted is inserted in the top opening, and the pen is filled with a small brush with violet or other dye, the supply being generally enough for at least 20 figures.

# What is at the Centre of the Earth?

WE happen to have received recently three different articles bearing on this subject, and, considering the interest, the mystery, and the importance of the question, we think it desirable to publish them in series, and hope they may elicit comments and criticisms from other writers.

It seems remarkable that though we are able to investigate the composition of stars millions of miles away, and though (with the exception of a few comparatively small patches) we know every inch of the surface of the globe, and have investigated its composition to the smallest particular, yet we have not the slightest idea of either the chemical composition or physical state of what exists but a very few miles beneath our feet.

The diagram given below, which is taken from the *Science Year Book*, illustrates this in a most convincing manner. A glance at this is sufficient to make us doubt the possibility of the theory very generally held that the temperature increases so rapidly that substances of the earth at so small a depth from the surface as 30 miles, or only $\frac{1}{266}$ of the diameter, is at a heat sufficient to melt the most refractory substances known.

There are but few data to go upon. It is generally supposed that the earth weighs about $5\frac{1}{2}$ times as much as would an equal bulk of water. The specific gravity of granite, of which the greater part of the *known* world seems to consist, is only 2.6. But the pressure of the superincumbent strata would be so enormous on the underlying portions a few hundred miles down as to greatly increase its density and raise its melting point. But this pre-supposes the earth to be solid throughout. If the interior be hollow, many other considerations come in. We shall see, however, whether theories of a hollow interior can be considered tenable.

## The Interior of the Earth.

By BERESFORD INGRAM, B.A., F.C.S.

IT is generally conceded that the present shape of the globe is due to the fact that at one time the earth was a semi-fluid mass which revolved round its axis with a definite uniform velocity.

Experiments have been conducted with spheres of plastic material rotating with different velocities round their axis. These have proved indubitably that, under the above conditions, a flatness is always produced at the two extremities at which the axis emerges, while a corresponding increase in diameter is observed midway between these two extremes. It was also noticed that the greater the velocity of rotation, the more *oblate* the mass became.

Nevertheless, there are, in this, many experimental considerations which would not be applicable to the earth in its earliest history; so that while the plausibility of the demonstration must be fully admitted, it would be unwise to accept the supposition as conclusively established.

On the other hand, there does exist absolute proof that the earth is a cooling body. The high temperatures that have been registered at the bottom of mines and deeper borings prove the point beyond all doubt that, as the centre of the earth is approached, the temperature becomes higher. Heat must, therefore, be travelling from the interior to the surface, and thus daily dissipated, in almost inconceivable quantities, into space.

Taking the average of all the observations, it would appear that the temperature rises 1° Fahr. for every 51 feet of the earth's crust penetrated. It follows that, at a distance of less than two miles, the temperature is the same as that of boiling water; while at a distance of 30 miles below the surface, the temperature is sufficient to melt iron; in fact, at a distance of 50 miles the temperature is higher than any that has yet been artificially produced. There still remains the best part of 4,000 miles to travel before the earth's centre is reached. It would, therefore, be meaningless to calculate the temperatures that exist below fifty miles.

The existence of enormous temperatures naturally raises the question, What is the condition that prevails in the interior? Is the rock in a liquid condition, or can it conceivably be in any other state?

On this point geologists seriously disagree.

Undoubtedly as the earth's crust is penetrated a temperature must be reached which is sufficient to melt solid rock under ordinary circumstances, but it is equally certain that at that depth an enormous pressure is affecting the underlying mass. Now it is well known that if the pressure on a solid is increased the melting point of that solid becomes higher, and, moreover, that different substances are differently affected by the increase in pressure.

As it is not known what is the composition of the rocks that exist at these great depths it becomes impossible to do anything but conjecture what effect the pressure has on the melting point.

When the pressure is relieved in any way (as is supposed to have taken place in volcanic outpourings of lava) it would appear that the condition necessary to keep the rock in a solid state is destroyed, with the observed result.

These considerations have led some scientists to consider the earth as a solid mass with its interior at a very high temperature.

But it may happen that the increase in pressure at certain depths is not sufficient to prevent the liquefaction of the rock, in which case the earth would have a solid crust with a liquid interior.

It may be, however, that, after a certain depth, the

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pressure becomes great enough to prevent further liquefaction, in which case a section through the earth would show three concentric rings, the innermost having a diameter of over 7,000 miles and marking the extremities of the solid nucleus, then a ring, about 7,800 miles in diameter, defining the limits of the liquid substratum, and finally there would be the earth's crust, which, varying as it would according to the position of mountain, land, and water, probably in no place exceeds a depth of over 70 miles.

A very potent argument has been urged against this second assumption to the effect that, if the crust were so thin as the theory states, it would yield to the deforming influence of the sun and the moon; in which case the water would be drawn up with the earth, and thus no sensible tidal effects could be produced. In order to counteract this attraction it would be necessary to admit that the thickness of the earth's crust is at least 2,000 miles.

An unsatisfactory compromise has thus been suggested, by which it is supposed that the earth is at the present time solid throughout (having passed through the stage of alternate solidity and fluidity), but that large fluid cavities exist throughout the mass.

If the reader should find himself incapable of coming to any definite conclusion on this question, how much more impossible is it for the student of geology (or mathematics) to settle the difficulty satisfactorily? Each theory initially commends itself with much plausibility to its reader, but as the more important but less apparent tests are applied, certain defects come into prominence.

### FISHER'S THEORY.

Fisher succeeded in forming a theory that would comprehend and explain all the difficulties that each previous assumption had encountered.

He accepted the idea of the existence of a liquid substratum, with this difference, that it consisted of a mixture of *fused* rock and a *dissolved gas* (in all probability hydrogen).

The origin of earthquakes and volcanoes can be satisfactorily explained on this assumption, which has the additional qualification of accounting for the appearance of vast quantities of that gas (*i.e.*, hydrogen) in all volcanic outbursts. Furthermore, the fused mass, which Fisher supposes to exist, would not give rise to any tides within the earth's crust, and thus one of the most serious objections to the "liquid substratum hypothesis" (which is itself based on the fundamental notions of the effect of heat on solids) is satisfactorily removed. At the same time the theory admits the possibility that the fused mass *may* communicate its movements to the earth's surface (although not in the form of "tides"), which deduction, taken with all the other scientific explanations, should strongly recommend the theory to all whom it may interest.

# Australian Meteorology

UP to the present day, each of the various institutions for studying weather in Australia has been working independently for its own local and particular needs, and there has been no central bureau whose business it has been to gather and discuss this wealth of priceless material, now rapidly accumulating, to advance the knowledge of the meteorology of this portion of the globe as a whole. It is true that valiant attempts have been made by individuals to tackle this inquiry, and, thanks to their efforts, much valuable information has been gleaned.

Australia, as everyone knows, is a very large tract of country, extending considerably in both latitude and longitude. There is undoubtedly a very close connection between Indian and Australian weather, so that a rigorous study of the latter would, in all probability, be extremely useful in helping to unravel the vagaries of the former.

Disastrous droughts are not infrequent in Australia, and at these epochs, when the natural water supply of the country is cut off, millions of sheep die, and in consequence the assets of the country are considerably diminished.

It is therefore of the highest importance for the future welfare of the Australian Continent that, in addition to the various institutions which are at present collecting and publishing meteorological observations, there should be added a central bureau to take a broader view of the situation and co-ordinate and discuss not only the Australian meteorological data *in toto*, but those gleaned from neighbouring islands and seas.

According to recent information there seems a prospect of such a scheme being brought into being, and if it be carried out in a practical manner, the country will undoubtedly be benefited in the course of time. Droughts, of course, cannot be stopped, but their effects may be mitigated by an intelligent use of the knowledge that will be gained by such an institution, after a careful study of the weather changes, changes which have every appearance of being of a periodic nature.

# A Successful Flying Machine.

IT is nearly two years (February, 1904) since we announced the successful ascent by Messrs. Wilbur and Orville Wright in an aëroplane of their construction in North Carolina. It seemed at the time as if the accounts might have been exaggerated, and as no further news was heard of these inventors until a few days ago, it was natural to suppose that the apparatus was not quite so perfect as the sanguine makers had at first hoped. Now, however, in a letter which was read at a meeting of the Aëronautical Society on December 15, they make the startling announcement that they have been steadily continuing their experiments, and have been rewarded with highly satisfactory results. No details of the machine itself are given, for the inventors do not wish such to be published at the present stage, but it is presumed to be a motor-propelled aëroplane, entirely dependent for its lifting power on the screw propellers. They state that during September and October last flights were made on eight different days, and that the distances covered during these flights varied from 11 to 24¼ miles. The speed was about 38 miles an hour, and on each occasion the machine returned to its point of departure without suffering the slightest damage. The longest flight lasted no less than 38 min. 3 secs. Such an account may well be received by the general public with some incredulity, but we know the inventors to be thoroughly sound and unassuming men who would not be likely to make such an announcement without very good grounds.

# Photography

## Pure and Applied.

By CHAPMAN JONES, F.I.C., F.C.S., &c.

*Is Development a Reversible Reaction?*—It seems that my remarks under this heading in the last number did not make clear, except, perhaps, in a negative sense, what I consider the word *reversible* should mean in its application to development. "Many chemical processes are reciprocating, *i.e.*, the original substances may be re-obtained from the products of the reaction." Such changes are termed reversible. In a purely chemical sense, we may be satisfied with the chemical identity of the original and the reproduced substances, but if development as distinguished from mere chemical reduction is reversible, the original and the reproduced substances must be photographically as well as chemically identical. To be still more explicit I suggest the following experiment:—Let a plate be subjected to a graduated exposure, leaving a part unexposed, and let it be treated as follows in the dark, removing a sample strip at each stage for subsequent critical examination: (1) Develop it. After simple washing (not fixing), (2) treat it with a solution of the products of the complete oxidation of the developer used. This should restore the plate to its condition before development. (3) Treat it a second time with the developer. If development is a reversible reaction the image will again be developed up as at first. The unexposed silver bromide is still present, so that in the second development a definite distinction is made between developable and non-developable silver salt.

If development is a reversible change it may be expected that very interesting results will follow. Perhaps one of the most important of these will be the indication that the change produced by light (that is the difference between developable and non-developable silver salt) is independent of the halogen. The possibility of changing a silver salt that has been made developable by exposure into another silver salt, without losing its developable property, a fact long since known, may be considered as pointing in the same direction. And the case now supposed would go a step further, the halogen being removed entirely and afterwards restored to the metal. Experiments seem to prove that the developable condition does not depend on the medium that supports the silver salt. If the change is in neither the halogen nor the medium, we seem almost driven to the conclusion that it is in the silver. And this reminds us of General Waterhouse's experiments, in which he got the developable condition on a polished silver surface, though I believe he failed when the silver was cleaned by treating it with acid and heating it.

*Superposed Stereoscopic Prints.*—Those stereoscopic pictures supposed to be made by printing the one member in red and the other in green, the one over the other, and that are viewed by spectacles having a red and a green glass, one for each eye, have nearly always bothered me, and, I suppose, other people, by struggles between stereoscopic and pseudoscopic effects, and, apparently, other confusions, in some parts of them. Mr. Alexander Thurburn, of Keith, Banffshire, in connection with this subject, has recently sent me two stereoscopic diagrams of a pyramid in red and green lines, but in the one the lines are on a white ground and in the other on a black ground. Although the disposition of the coloured lines is the same in both, everyone who looks at them through the coloured spectacles finds the one pyramid to project and the other to recede. By turning the card on a horizontal axis the apexes appear distinctly to move in opposite directions, as they would in the case of a solid and a hollow pyramid. The question was, Is this difference the effect of the difference in the background, and if so, why? I soon found that on the dark ground the lines seen through either coloured glass were those of the same colour as the glass, but on the white ground only the green lines were seen through the red glass and the red lines through the green glass. It is clear, therefore, that as the coloured lines are similarly disposed in the two diagrams the one must appear stereoscopic and the other pseudoscopic. The reason is clear. The red lines seen through the red glass appear white and are, therefore, lost on a white ground but visible on the black. Through the green glass the red lines are apparently black, and, therefore, they show on the white but not on the black ground. The green lines are similarly affected, but in the reverse sense.

In the case of the stereoscopic pictures referred to we have to consider red and green, and the white surface these are printed on. Through the red eye will be seen the green if surrounded by either red or white, and also the red where it is surrounded by green. Through the green eye will be seen the red when surrounded by either green or white, and the green when surrounded by red. As each eye sees, or may see, parts of both the red and the green pictures and cannot see other parts, if each of the stereoscopic pair is printed in a single colour it seems that pseudoscopic and stereoscopic effects must be mixed and confusion result, unless the subject is a very exceptional one. Mr. Thurburn has been good enough to send for my inspection a number of the "Plastische Weltbilder," in which this confusion seemed to him to be absent. I find it is also absent to me. On careful examination I find that the pictures for both eyes are printed in both colours—that is, each eye, using the coloured spectacles, sees parts of both red and green, but not the same parts. The distribution of colour is systematic throughout, and a conspicuous example will show the character of it. A shop front in the foreground has white sash bars in front of a dark interior, and over the front the name is in dark letters on a light ground. The picture provided for the one eye and the picture that is really seen by that eye, has green sash bars and red letters. The picture for the other eye has red sash bars and green letters. The sash bars are light on a dark background, and the letters are dark on a light background. Therefore the representation of objects by such means is not a simple case of printing the one picture in red and the other in green, and discriminating them by means of spectacles with one red and one green eye. This simple and straightforward method must, I think, be faulty, and success appears to depend on a distribution of colour by hand. If it is so, these productions cannot rightly claim to be photographs, and the method is not useful for scientific purposes, as it might otherwise be.

XUM

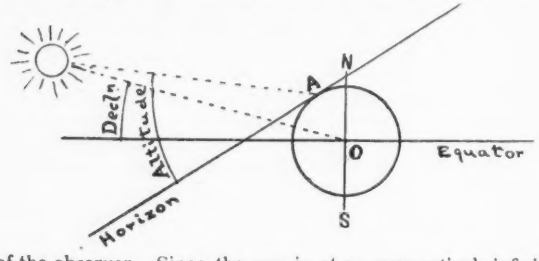
## Answers to Correspondents.

**Ignoramus.** *Altitude of the Sun.* Many books on Practical Astronomy define the terms used, though not in a very explicit manner. Perhaps the following may make it clear to you:—The *altitude* of the sun is the angle at the observer's eye between the sun and the horizon. The *declination* of the sun is the angle between it and the Equator (produced). The declination at noon each day is given in any astronomical ephemeris (*vide* "Science Year Book"). Therefore, knowing the declination, one can find the altitude at any given latitude by subtracting the latitude from 90°, and *adding* the declination if summer, or *subtracting* it if winter (when sun is south of Equator). Thus, if latitude 51° 28',

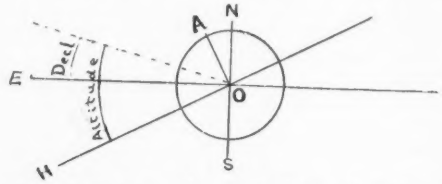
Deducted from 90° = 38° 32';
Declination at noon January 1st = 28° 3'28";

∴ altitude = 10° 28' 32".

The following diagrams explain this, where A is the position




of the observer. Since the sun is at a comparatively infinite distance, the altitude will be practically the same at O (centre of the earth) as at A. Then in fig. 2, N O E is a right angle, as is A O H. Deducting the common angle A O E (= the




latitude), we have N O A (= 90° − latitude) = E O H, and E O H + Declination is the altitude. This, of course, is the principle for finding one's latitude at sea. *Observe* (with a sextant) the altitude of the sun above the horizon, add or deduct the declination (as given in tables), and deduct the result from 90°. This gives the latitude.

**Cecil Evans.** Though we have referred your letter to several authorities, we fear it is not sufficiently explanatory for us to comprehend your meaning.

**G. P. Blake.** Remember that the obliquity is not constant. It is diminishing *about* 0"4 annually, though the *exact* diminution can only be surmised by theory. The change should not be "put down to precession."

## To Make Iron Grow.

THE Franklin Institute has awarded the Elliot Cresson Gold Medal for a new process by which iron can be made to grow. This consists in heating and cooling the bar of iron which it is intended to magnify to a "critical" temperature a number of times. The results are extraordinary. To the Mechanical Science Section of the American Association two bars of iron cast in one mould were presented for critical inspection. One bar remained exactly as cast. The companion bar had been caused to grow gradually in cubical dimensions till it is now 46 per cent. larger than the other, the weight remaining the same as before expansion. Both bars were machined on one side to show the texture and metallic appearance; and it was difficult to detect any change except the very apparent difference in size. It is said that important practical applications have already been found for this remarkable discovery.

# NOTES.

## ASTRONOMICAL.

By CHARLES P. BUTLER, A.R.C.Sc. (Lond.), F.R.P.S.

### Diffraction Grating Replicas.

FOR some years past both physicists and astronomers have been using the excellent Diffraction Grating Replicas made by Mr. T. Thorp, of Manchester, and now he is able to make the interesting announcement that he has been successful in producing *concave* replicas. There will be a very great field for the application of this form of spectroscope, which is self-contained and needs neither collimating nor telescope lenses. At present the replicas are only of plain celluloid, but experiments are in progress for silvering the diffracting surface, when the brightness of the spectra will be greatly enhanced.

Another distinct advance is the making of the grating films on glass rings, so that there is no glass for the light to pass through, and these will be very useful for investigations of ultra violet radiations.

### Possible Relationship between Light and Velocity Variations of Variable Stars.

In a recent paper by R. C. Curtiss the author points out an important coincidence which he has found to exist between the variations of magnitude and radial velocity of the variable star W Sagittarii. When these were plotted it was at once seen that there was a most striking concordance, the two curves corresponding not only in general form, but in most of the minor inflections. The *light maximum*, according to the latest values, occurs 0·99 day after periastron, and almost exactly at the epoch of *velocity minimum*. Comparing the most recent photometric measures of the light variation, from the Harvard College Observatory, with those made by Schmidt some thirty years previously, there are seen to be numerous differences, and it seems not improbable that these may be more or less due to actual changes in the system of this star during the interval which has elapsed between the two series of observations.

### New Views about Comets.

Various novel facts concerning the formation and appearance of the tails of comets have recently been described by Professor Barnard, the discussion of which leads him to think that the views generally accepted may have to be considerably modified in future.

Although no explanation has been definitely found to cover all the many details exhibited by the growth and dissipation of a comet's tail, that of Bredechin has probably received most favour. This ascribes the varying forms of tail to different constitution of the matter evolved from the comet, on which the resulting effects of the sun's repulsive force will be to produce streams of cometary matter extending in curves of varying degree, depending on the density or other physical properties of the substance. In this and most other theories it has been customary, however, to ascribe practically all the cause of the phenomena to the action of the sun, supposing the comet to merely supply the material to be acted upon.

During the last ten or twelve years, however, the application of photography has resulted in the discovery of many new features which are rather of a revolutionary nature, and are not easily explained. Professor Barnard now thinks that three main causes are at work.

First, the sun, which produces in the nucleus of the comet a disturbing action, and which influences the general direction of the tail-producing particles. Second, the comet itself, in which a strong ejective power seems to be located. This is proved by the frequent formation of straight minor tails or streams of particles which are often seen to issue at large

angles to the general direction of the main tail. Such peculiarities are quite contrary to the effect produced by the sun. In many cases it would seem that this emissive power is great enough to entirely overcome the direct pressure of the sun's light. Not only this, but the sun's light appears to have no bending effect towards the radius vector, as might be expected. Third, an outside influence quite apart from the comet, which is shown by the many rapid distortions and deflections of the tail. There appears to be clear evidence that this is some sort of resistance offered by a kind of medium not uniformly distributed in the planetary spaces, as, for instance, a meteor swarm. Encounters with such a medium would readily explain the sudden brightening up of some comets when long past their theoretical maxima, as was shown by Sawerthal's comet in May, 1888, or it might account for the breaking up of such a comet as Biele's. It would seem that something of this nature was chiefly instrumental in producing the special peculiarities of the tail of Brook's comet in October and November, 1893. Photographs taken by Barnard on November 2 and 3 show most remarkable changes, and these are strikingly shown in a composite picture made by superposing the two plates star for star, giving the two positions of the comet with 24 hours' interval. There is a difference of nearly 15° between the directions of the tail in the two cases, while it is remarkable that the position of the ends of the tails do not appear to have materially changed, and various portions are seen to be detached from the main stream.

Basing on these evidences of quick change a suggestion that every active comet should be photographed as often as possible, he points out that this might with advantage be done hour by hour during every night, as by this means the actual changes in any part of the cometary matter might be followed with certainty, and it may be possible to determine the exact value of the motions of the particles in the tails of various comets, or the same comet, at different distances from the sun, and so give the true law of the velocities of these particles apart from any theory. It seems then more likely that the different tails of a comet are all made up of the same kind of particles, and the cause of their different directions is that they are ejected towards different parts of space by a force residing in the comet itself. The evidence of the spectroscope, so far as it goes, has certainly not shown them to be of very diverse elements.

# CHEMICAL.

By C. AINSWORTH MITCHELL, B.A. (Oxon.), F.I.C.

## Acetylene Black.

THE old method of obtaining a black pigment for printing ink was to conduct the smoke from burning wood, oil, or resinous substances into a cylindrical chamber in which were hung sheep skins or sacking. An inverted iron cone was suspended from the top of the chamber, which it fitted so exactly that when lowered its edges scraped the suspended sacking and removed the black deposit. There are numerous other methods based on the same principle, such as, for instance, that claimed in a recent U.S.A. patent, in which several oil lamps are burnt beneath a hollow cylinder through which passes a current of cold water, the deposit of lampblack being removed by a fixed brush as the cylinder revolves. However carefully prepared, lampblack invariably contains more or less tarry oil, which being yellow detracts from the depth of tone, and the usual method of removing this is to calcine the black in closed iron boxes with only a small opening for the escape of impurities, every precaution being taken to prevent the admission of air. The discovery of natural gas in various parts of the United States put a cheap source of black at the disposal of the maker of printing ink, and led to the American inks acquiring a high reputation for depth and richness of tone. The gas issues from borings 2000 feet in depth, and is burned in jets beneath revolving iron rings, on the surface of which the black is deposited, about 1000 cubic feet of gas being consumed in the production of 1 lb. of gas-black. The product is much purer than ordinary lampblack, and in the crude state contains 92 to 93 per cent. of carbon, 5 to 6 per cent. of oxygen, 1 to 2 per cent. of hydrogen, and traces of mineral matter. Its tinctorial power is also much higher, and it requires less purification than lampblack. A still purer and more intense black has recently been prepared by Dr. Frank by exploding a mixture of acetylene with carbon monoxide or dioxide, and it is claimed that this product is superior to the best American gas-blacks both in quality and covering power. On the other hand, its cost is likely to be greater than the American blacks, which at the present time fetch about 3d. or 4d. a pound.

## Water from the Simplon Tunnel.

In the course of the construction of the Simplon Tunnel numerous springs were encountered, and the water from one of these, about five miles from the Italian end of the tunnel, has been analysed by Mr. A. G. Levy. The water, which had a temperature of 113° F. at the point of collection, was clear, colourless, and without smell, but had a saline taste. It contained 106·5 grains of solid matter per gallon (about five times that of London drinking water), consisting principally of calcium sulphate, with a considerable proportion of magnesium sulphate, and small amounts of other salts. It was quite free from organic matter and also from chlorine, which latter fact was the remarkable characteristic of the water; since, considering the distance it must have travelled underground to attain its high temperature, one would have expected it to come in contact with soluble chlorides somewhere on its way.

## Photo-Active Properties of Rabbits' Blood.

Experiments have been made by Dr. V. Schläpfer, of the Pathological Institute of Zurich, to determine whether blood is capable of affecting a photographic plate in the dark. For this purpose the fresh blood of albinotic and pigmented rabbits was employed, with and without previous exposure to light, and also after treatment with prussic acid and potassium chlorate. In each case the plate was covered with black paper, on which was placed a photo-neutral capsule of paraffin wax containing the blood. It was found that the blood of pigmented rabbits had a very much weaker effect upon the plate than that of albinotic animals. The activity of both disappeared after some days, but could be restored again by exposure to light. Blood treated with prussic acid was invariably inactive, whereas that of animals poisoned with potassium chlorate was always active. The stimulative influence of light upon the photo-activity of the blood has suggested to Dr. Schläpfer a theory to account for the marked difference in the behaviour of the blood from the pigmented and the albinotic rabbits. He considers it possible that in the case of the albino the blood circulating in the cutis may be acted upon to a considerable extent by the light and thus rendered photo-active, whereas the pigments in the skin of the brown rabbit may act as a light-screen and weaken the effect of the rays.

# GEOLOGICAL.

By EDWARD A. MARTIN, F.G.S.

## A Twin-Earthquake.

DR. CHARLES DAVISON keeps unceasing watch over the various earthquake shocks which are constantly visiting our islands, more frequently perhaps than most people believe. In a recent paper he has described the Doncaster earthquake of April of this year. He tells us that it was a twin-earthquake, with its principal epicentre half-a-mile north of Bawtry, and the other about four miles east of Crowle, close to the centre of the Hessle disturbance of April, 1902. Last April the earthquake-area included about 17,000 square miles. He says that a twin-earthquake is probably due to the differential growth of a crust-fold along a fault which intersects it transversely, the first movement as a rule being one of rotation of the middle limb, accompanied by the almost simultaneous slip of the two arches, and followed soon afterwards by a shift of the middle limb.

XUM

## The Scuirr of Eigg.

At a meeting of the Geological Society held on December 6, Mr. Alfred Harker read a paper on "The Geological Structure of the Sgùrr of Eigg." The mention of this phenomenal mass of pitchstone naturally recalls to mind the very full description which we have had from Sir Archibald Geikie of the island, and the deductions which he has drawn as to the remarkable changes of level which have taken place, and the vast amount of denudation which has resulted in the formation of the Scuir (so spelt by Sir Archibald). The pitchstone is a massive sheet some 400 feet thick, and reposes upon alternating basalts and dolerites, which make up the greater part of the island. Beneath the pitchstone there are in two places accumulations made up of fragmentary materials, and these the latter geologist regarded as river-gravels of the age of the pitchstone, which overflowed into the valley of a stream which has since disappeared. The fragments of the gravel have alone been preserved by the pitchstone protecting it from denudation. Mr. Harker is unable to accept Sir Archibald Geikie's view. He thinks that the pitchstone may have been intrusive, and does not think that its base is reconcileable with that of a river valley. The fragmentary deposit is in one place, he states, a volcanic agglomerate, probably filling a small vent, and the other appears to him as a bedded agglomerate, but this he admits has been re-arranged by water action. There are contained in the deposits abundant blocks of Torridonian and Oolitic sandstone, with fossil wood of Oolitic age, and these are held to have been forced up from below. In this respect there is perhaps some failure of evidence, and some geologists will not regard this explanation as a probable one. It should be added that Sir Archibald adheres to his own explanation of the origin of the fragmentary deposits, and no doubt more will be heard of the matter now that the leading geologists differ radically as to its origin.

## Pleistocene Lake at the Mouth of the Tagus.

At the same meeting a paper was read by Prof. Edward Hull concerning the "Great Pleistocene Lake of Portugal." The margin of the former lake was probably formed by the granite of Das Vargans and Cunheira. Miocene times are thought to be represented by the Almada Beds, and the Pliocene not being represented, except possibly by certain glacial deposits, Prof. Hull thinks that the period was one of great uplift, and this resulted in the excavation of the sub-oceanic gorge which marks the seaward extension of the River Tagus. Thus the lake was finally drained by the Tagus cutting a channel at the harbour of Lisbon, upon the elevation of the land to about its present level.

## Glaciation in Snowdonia.

Evidence of the Glacial Epoch are numerous in North Wales, as all acquainted with Snowdonia are well aware. Our illustrations give two well-marked types of scenery. Fig. 1 shows a fine series of moraine hillocks near the Devil's

Fig. 1.

Fig. 2.

Kitchen, at the head of Nant Ffrancon valley; and fig. 2 gives the *roche-moutonnée* appearance of surface-rock resulting from the planing power of a mass of moving ice, taken from the same neighbourhood.

# ORNITHOLOGICAL.

By W. P. PYCRAFT, A.L.S., F.Z.S., M.B.O.U., &c.

## Humming Birds in England.

AT the meeting of the Zoological Society on November 28, Captain Pam gave a most interesting account of his attempt to start a colony of humming birds at the gardens of the Society, and, though this attempt was frustrated, the greatest credit is due to Captain Pam for the strenuous effort he made to achieve this end. He left Venezuela with about half-a-dozen specimens of *Petasophora iolata*, the Bolivian "violet ears" of Gould's monograph of these birds; but, unfortunately, only one reached the gardens alive, and this has since died. He fed his birds on a mixture of sugar and meat extract, a diet which seems extremely well suited for these delicate birds, inasmuch as he succeeded in keeping his captives alive, and well, longer than many residents in Venezuela who have continually endeavoured to keep these birds in aviaries, but without success—two months being about the record.

Humming birds appear to be late feeders, coming out just when other birds are going to roost. They are also heavy sleepers; so much so that Captain Pam found it difficult to awaken his birds after they had finally retired to roost. They appear to be extraordinarily sensitive to shock, so much so that should the cage in which they are confined receive a sudden jar, they lose their foothold—for the feet are remarkably small, and but little used—and tumble to the bottom of the cage. Whenever this happens, it results in a total loss of the power of movement in the wings; the birds become unable to regain the perches, and speedily die.

It was believed that this bird was the first humming bird ever brought into this country alive. But Mr. Pocock points out (*Field*, December 9) that in July, 1894, no less than eleven specimens of *Trochilus cornutus* were brought over in the s.s. *Nile*, and were ultimately purchased by the late Mr. Erskine Allen, of Gray's Inn. It would be interesting to have further particulars of these birds.

## The Breeding Plumage of Birds.

In a very short but extremely interesting article in the *Field*, December 2, signed "R. L.," a new interpretation is given to the "eclipse" plumage of the Mallard and other Anatidæ. It is suggested that the "eclipse" dress corresponds

to the non-breeding plumage of, say, the Waders, while the brilliant livery worn during the greater part of the year really answers to the breeding dress of the Waders, which is worn for a short period only. But for the need of protection during the period of quill-moulting it is contended the Mallard would have assumed a permanent breeding dress, as in the case of the Sheldrake, or of the game-birds for example.

Whenever the male birds are brilliantly coloured we may assume, he points out, that this is a permanent breeding dress, and when the hen stands in no need of a dull protective dress she also assumes a similar plumage.

With this interpretation we heartily agree.

### A New British Thrush.

The *Field*, December 2, contains an account by Mr. T. Whittaker of the occurrence of the Dusky Thrush (*Turdus dubius*) in Nottinghamshire. The bird was shot near Gunthorpe, and is described as having a flight like that of a jay, and a note like that of the fieldfare. This bird is a rare straggler to Europe, having occurred but twice in Norway, once in Germany, once in Belgium, and four times in Italy.

### Leach's Petrel in Berkshire.

We learn from Messrs. Rowland Ward and Co. that they have recently received a specimen of Leach's petrel in fine condition, which had been obtained during the last week in November at Caversham, having probably been driven inland by the late strong westerly winds. It proved to be a male, on dissection.

## PHYSICAL.

By ALFRED W. PORTER, B.Sc.

### Wireless Telegraphy.

IN the *Annalen der Physik*, J. S. Sachs describes experiments which throw some light on the part which the earth itself plays in wireless telegraphy. He concludes that transmission is better the higher one is above the ground, and thence that the earth is detrimental to the propagation of electric waves.

### Motors and Dust.

Mr. W. R. Cooper has recently described experiments carried out on a flour-covered track with a tricycle hauled along at various speeds. A slack tyre is shown to raise more dust than one pumped tight. A square box carried at different heights above the ground raises less dust the higher it is above the ground; very little is raised when the box is inclined so as to throw the air down.

### Phosphorescence and Stokes' Law.

Professors Nichols and Merritt, in the *Physical Review* for October, describe experiments bearing on the phosphorescence of Sidot blende (zinc sulphide) under various exciting causes. Amongst other results they show that when the exciting light is limited to a range of wave length from ·470 to ·497$\mu$, the luminescence observed after the exciting light is cut off extends to wave lengths in the violet certainly beyond ·46$\mu$. There thus appears to be the same violation of Stokes' law which they have previously found to occur in the case of fluorescence. In explanation of this statement we may point out that, according to the law enunciated by Stokes, the excited light must always be of longer wave length than that which excites it. It would seem that under ordinary circumstances this law must be true whenever the radiation depends merely upon temperature, as, for example, when dark heat is focussed upon a platinum black surface and makes it white hot. On the other hand, it has been shown that even in such a case the result is due merely to the fact that the region of maximum energy of the spectrum is situated for the hottest known bodies in the infra red. If temperatures were attainable so high that the maximum shifted into the ultra-violet, the opposite to Stokes' law should be expected to hold.

When, however, the luminescence is not due merely to the temperature—and such is the case for all kinds of phosphorescence and fluorescence—there is no reason known why Stokes' law should hold; and we need not be surprised therefore to find that it is not valid. It is of interest, moreover, to point out that it has recently been shown that Stokes himself threw doubt upon it in his later correspondence.

### Refractivity of Fluorine.

Messrs. Cuthbertson and Prideaux have succeeded in determining the refractive index of Fluorine. Special interest was felt in regard to this question because of the relations which Cuthbertson had previously shown to exist between the refractivities of the elements. Taking the non-valent column of elements as arranged in a periodic system of the elements, he showed that their refractivities were in the following ratios:—

| He | Ne | Ar. | Kr | Xenon |
|---|---|---|---|---|
| ½ | 1 | 4 | 6 | 10 ; |

he further, by obtaining data for other elements, proved that these numbers appeared to be characteristic of the particular rows in the Periodic Table to which these elements respectively belong. Thus the value for sulphur (which lies in the same row as Argon) is four times that for Oxygen (which lies in the same row as Neon). Chlorine and Bromine and Iodine have numbers in the ratio of 4, 6 and 10. Now Fluorine heads the column in which these numbers lie, and in order to prove the generality of Cuthbertson's relations it was necessary to find the value of Fluorine. As the result of a very difficult investigation carried forward with great zest by these investigators it turns out that this element also conforms to the rule. As experiments on other substances are proceeding we may hope shortly to be able to classify other elements either as conforming to this rule or to some more general one of which it is a special case. Unfortunately the refractivities of compounds, of which many are known do not supply much information on this question, because the refractivities of compounds are not the algebraic sum of the refractivities of their constituent atoms, although in most cases this additive law is approximated to within perhaps twenty per cent. We hope to return to this matter before long in order to indicate the physical cause of these simple relations between the refractivities of the elements.

## ZOOLOGICAL.

By R. LYDEKKER.

### Colour Change in Gibbons.

How imperfect is still our knowledge of the life-history of many animals has been remarkably illustrated of late by a gibbon from the Island of Hainan which has for some time been living in the Zoological Society's Garden. When received, and apparently full grown, it was jet black all over; after a time, however, it changed its coat, when, to the astonishment of everybody, it came out in a greyish buff livery, the bare skin of the face alone retaining the original sable hue. Probably certain allied species of gibbons undergo a similar colour-change with age, although the Himalayan hulock and the Sumatran siamang are apparently always black.

### Variation in Lizards.

A very remarkable paper on the pattern and colour variation displayed by different phases of the wall-lizard of southern Europe has recently been published in the *Transactions* of the Zoological Society. How great are the variations in these respects, a glance at the beautiful series of plates with which the paper is illustrated will serve to show. By some authorities these variations have been—and probably still are—considered as of specific importance; and it is from the boldness with which the author, Mr. G. A. Boulenger, sweeps away such nominal distinctions that we have ventured to call the paper remarkable in these days of incessant splitting of species and races. "Of late," writes the author, "a tendency has sprung up to greatly multiply the species and thus destroy the old conception of *Lacerta muralis*. I doubt whether such attempts will conduce to a better understanding of the subject. . . . Characters of form and coloration are given as distinctive which, on examination of even moderately large series of specimens prove to be worthless, while others of greater importance have been overlooked or neglected." Evidently much water has still to

run through the bridges before our conception of what constitutes a species, or even a race, can be regarded as finally settled.

## The Senses of Animals.

Several interesting communications have appeared during the last few weeks concerning the senses and psychology of animals. A German authority has, for example, expressed the opinion in somewhat confident terms that fishes are stone-deaf; this view being based on the structure of their internal ear. A discussion on the subject has appeared in the columns of the *Field* newspaper, in which several anglers point out that fishes can perceive vibrations, from which it is inferred that they can hear. This is, of course, begging the question, as if the German aurist is right in his contention that fishes lack the essential parts of the organ of hearing, it is quite evident that vibrations must be perceived in some other manner. A second Continental authority has adduced evidence to show that ants recognize one another by means of the sense of smell, which is apparently located at the base of their antennæ. Finally, a third foreign naturalist, who writes from Costa Rica, is of opinion that there is no difference in kind between the essentially automatic actions of even the lowest organisms and the manifestations of the human will, but that there is a gradual transition from one to the other.

## New Bats.

The study of bats has occupied a large amount of attention during the last few months, and a number of new species and races of the horseshoe and leaf-nosed groups have been named. By far the most interesting addition to the list is, however, a new mastiff-bat from West Africa, since it is a near relative of a group hitherto known only from tropical America. It comes, indeed, very close to the American *Molossus*, although it has been made the type of a new genus—*Eomops*.

## Papers Read.

At the first meeting for the 1905-6 session of the Zoological Society, held on November 14, Dr. Kidd discussed the arrangement of the fine ridges on the hands and feet of various species of mammals, chiefly monkeys and lemurs. Mr. Bonhote named two new species, and one race of Tibetan mammals, viz., a fox, a hamster, and a vole. Major Evans communicated notes on the gorals, or lesser goat-antelopes, of Burma; while Miss Bate gave an account of the mammals of Crete. At the meeting on November 28 Mr. Lydekker discussed the colouring of the guereza monkeys, and also called attention to a mounted specimen of the little known white-maned serow, or goat-antelope of China; Mr. Thomas exhibited and discussed a collection of mammals from Japan; and Mr. Regan proposed a rearrangement of the fishes of the southern family *Galuaxiidæ*. At the meeting of the Geological Society held on November 22 Dr. Smith Woodward described new remains of a species of an extinct genus of Chimæra-like fishes from the Lias of Lyme-Regis.

# REVIEWS OF BOOKS.

**My Life: A Record of Events and Opinions**, by Alfred Russel Wallace; in two vols. (Chapman and Hall; price, 25s. net.).—Among the many claims to attention possessed by Dr. A. R. Wallace's autobiography is that of furnishing a summary of most of the controversies which shook the mid-Victorian era. It was the day of controversies and of controversialists, perhaps because it was also the day of great generalisations; perhaps because scientific interests were less decentralised, and what interested one body of scientific workers interested them all. The controversies of to-day between Sir Oliver Lodge and Professor Ray Lankester and Mr. Mallock on Psychics, or between Mr. Bateson and Professor Karl Pearson on Heredity, rouse no such passions as those between the Darwinians and the theologians, or between Dr. Wallace (for example) and St. George Mivart and the other sceptics of Spiritualism. To read Dr. Wallace's record of these great controversies is to experience a sense of intimacy with another generation, as well as with other times. Dr. Wallace is the last of the great controversialists. He was one of the three who "kept the bridge" for Darwinism; but a controversy even of that embracing kind was not enough to absorb all his energies. Land nationalisation, Socialism, Spiritualism, and a fierce dispute with a fanatic about the configuration of the Earth were some of the subjects on which he argued, wrote, and spoke; and it is significant of the energy which he put into all that he did that the last named of these controversies—settled by the famous Bedford Level experiments—gave him more trouble and took up more of his time than any of the rest. The details, the correspondence, and the stages of these controversies are all related with great fulness in the two volumes of Wallace's "Life," and would be of the greatest interest and value even had he himself played a less prominent part in them. His position, however, with regard to them is of the first importance. To many people in this degenerate day he is chiefly remembered as the associate of Darwin in what people are sometimes pleased to regard as the "discovery" of the Darwinian theory. A theory of this kind is never "discovered"; it must be the outcome of the most patient and long-continued examination, observation, and confirmation of research. If it were otherwise, then Democritus or some of the early Greek philosophers who speculated on the origin of the universe might be claimed as the "discoverers" of Dalton's Atomic Theory, or of the Fourth State of Matter postulated by Sir William Crookes, and elaborated as a theory of Professors J. J. Thomson and Rutherford. In such a sense Dr. Wallace might—with much more justice—claim to be the discoverer of the Darwinian doctrine of the origin of species, for the idea came to him as a brilliant flash of inspiration while he was in the Malay Archipelago examining and classifying some of his zoological captures. "At the time in question," writes Dr. Wallace, "I was suffering from a sharp attack of intermittent fever, and every day during the cold and hot fit had to lie down for several hours, during which time I had nothing to do but to think over any subject that particularly interested me. One day something brought to my mind Malthus's 'Principles of Population,' which I had read about twelve years before. I thought of his clear exposition of the 'Positive checks to increase'—diseases, accidents, war, and famine—which keep down the population of savage races to so much lower an average than that of more civilised peoples. It then occurred to me that these causes and their equivalents are continually acting in the case of animals also. . . . Vaguely thinking over the enormous and constant destruction thus involved, it occurred to me to ask the question 'Why do some die and some live?' And the answer was clearly, 'that on the whole the best fitted live.' . . . Then it suddenly flashed on me that this self-acting process would necessarily *improve the race*, because in each generation the inferior would be killed off and the superior would remain, that is, *the fittest would survive*." The idea, thus furnishing one of the curious coincidences of science, occurred to Wallace while Darwin was working at it; but it is none the less to Darwin that the establishment of the great principle on a firm basis is due; and it is to him, as Dr. Wallace modestly admits, that we must ascribe the name of the real discoverer. In this extract we have touched upon only one facet of interest among the many for which these remarkable volumes are conspicuous. They were written by a man who was intimate with the best scientific intellect of two generations, and who has been generous in relating the points of contact he had with them.

**An Elementary Text-Book of Inorganic Chemistry**, by R. Lloyd Whiteley, F.I.C.; pp. 8 and 245 (Methuen; price, 2s. 6d.).—Students taking the elementary stage of the Board of Education examinations in inorganic chemistry will find all they require in this little book, which is too short, however, to include much more than the details essential for this particular purpose. It is well printed and illustrated, and gives descriptions of numerous experiments in such a way that students can repeat them for themselves.

**Radioactivity.** Professor Rutherford (Camb. Univ. Press, 10s. 6d. net).—The appearance of a second edition of this treatise so soon after the appearance of the first is an event which gives rise to an apology from the author to the purchasers of the first edition. However, so rapid and extensive have been the advances made in our knowledge of the subject, that everyone will concede that no apology is due. The present edition is to all intents a new book, although it is based upon the old one. Besides a rearrangement of the whole, three new chapters have been

added, which give a detailed account of the theory of successive changes and of its application to the analysis of the series of transformations which occur in radium, thorium, and actinium. The disintegration theory, about which there was much misgiving in many minds, still holds its ground as the most effective of all theories in co-ordinating the multitudinous experimental data which are known, and as providing a most powerful and valuable method of analysing the connection between the series of substances which arise from the transformation of the radio-elements. Many of the results of the researches during the past year have already been noted in this Journal; and it will be recalled that for these results Professor Rutherford is himself largely responsible. From the beginning, when facts were few and theories conflicting, he seems to have been marked out as the man possessing just those qualifications required in a pioneer investigator—viz., fertility of resources, and an adequate endowment of what many would call crudeness, which enables a man to go for and seize the main outlines of a subject while others are groping in the dark after irrelevant minutiæ. The result is a magnificent achievement; and everyone will welcome this fresh summarisation of the present state of knowledge by one from whom so much of it has come. We cordially commend this book both to the expert, to whom the possession of it is a necessity, and to the amateur reader or speculator, who, if not already acquainted with it, will be surprised at the ease with which it will enable him to enter into a real knowledge of this fascinating subject.

**Instruction in Photography**, by Sir William Abney (Iliffe and Sons; price 7s. 6d. net).—The fact of an eleventh edition of a book being published is in itself a complete proof of the value and usefulness of the work. Abney's "Instruction" has before now been aptly termed "a photographic classic," and contains all that an amateur, or professional either, should know. We should not like to go quite so far as to say that what is not in this book is not worth knowing, but it is safe to say that any matter omitted is beyond the scope of the ordinary photographer. Both the theory and the practice of this subject, which is now becoming so greatly enlarged, are carefully gone into. Besides considerations of the action of light on silver compounds, the development of the resultant image, the theory of lenses and stops, the preparation of gelatine and other emulsions, we have information on transparencies, enlargements, and copying. There are descriptions of the various modes of printing and preparing sensitive papers, as well as such more elaborate processes as photo blocks and three-colour printing, which latter especially has been considerably enlarged in this latest edition.

**British Rainfall, 1904**, compiled by Hugh Robert Mill, D.Sc., &c. (Edward Stanford; price 10s.).—This annual, so indispensable to all meteorologists, is a most complete collection of statistics relating to rain. Part I. contains a report touching on the work of "The Rainfall Organisation"—that is, the organisation for observing and recording rainfall; original articles on the rainfall on Ben Nevis; the driest October on record; and twenty-four years' records. Tables are given of the duration, &c., of rainfall; and accounts of the staff of observers, &c. Part II. deals exclusively with 1904, with discussions on the special characteristics of the year. The book is well got up, and contains a number of excellent maps and charts.

**The System of the Stars**, by Agnes M. Clerke. Second edition (A. and C. Black; price 20s. net).—It is already fifteen years since the first edition of this work appeared, and, as a result of the progress which the science of astronomy has undergone during that period, very extensive additions and corrections have become necessary. Among other features a number of excellent reproductions of photographs are now included, which add greatly to the interest of the book. Astronomers, and especially amateur astronomers, will welcome this up-to-date account of the stellar universe, resting assured that the information given is accurate and complete, as well as the style and wording being attractive. As the author remarks in the preface, "literary treatment is the foe of specialisation," and that literary treatment which renders clear and inviting the mysteries so often hidden beneath a load of abstruse phraseology is to be encouraged. We would advise those ordering the book to insist on the pages being cut before delivery.

**Quiet Hours with Nature**, by Mrs. Brightwen (London: Fisher Unwin).—This little book is probably one of the best that Mrs. Brightwen has written. Herein she discourses on many subjects—beasts, birds, and beetles, trees and gardens. Wide as is the range of these pages, yet nowhere are they dull; on the contrary, there is a sparkle in them that is refreshing, especially when one recalls the twaddle and crude inaccuracies that pass nowadays for "nature-study," and find favour with those who are supposed to possess a nice discrimination in the choice of books for the young. This volume is one which we hope will be largely read. The photographs from nature are charming, but many of the original drawings are, to say the least, unsatisfactory.

**Wild Wings**, by Herbert K. Job (London: Constable and Co.; 1905).—This book is unquestionably a valuable contribution to ornithological literature. Though entirely concerned with the ways of wild birds, many of which have been tracked to their inner fastnesses, it contains many facts that will throw light on the deeper problems of evolution and systematic ornithology. The author displays not only a wide knowledge of his subject but a rare discrimination in the selection of his facts, a combination which is all too rarely met with in the books of recent writers on this subject. Artists should find this book a boon, for the illustrations, which are numerous, may be described in many cases as superb, while their general average is far above that which we are accustomed to meet with. W. P. P.

**Trees**, by H. Marshall Ward, Sc.D., F.R.S., &c.; Vol. III., Flowers and Inflorescences (Cambridge: The University Press; 1905).—If the series of volumes on trees which Dr. Marshall Ward has set himself to write do not exactly furnish exciting or fascinating reading they will prove a very present help in time of trouble. This volume, like its predecessors, is in every way admirable. To the working botanist it will prove an indispensable companion, while to those who are desirous of taking up this study we cannot recommend a better book. To these last, probably this book would appear on a casual examination too technical, but a very slight acquaintance with its contents will show not only that this impression is quite erroneous, but that here, as in few other similar volumes, they will find a key to mysteries and delights which they had probably never suspected. The author calls special attention to a feature of this volume which should prove of value to the forest botanist. This is a supplementary table of classification, by means of which that most difficult of groups—the willows—may be distinguished by characters derivable from staminate or from pistillate flowers respectively. The illustrations which are profusely distributed throughout its pages are extremely well chosen, and many are of great beauty.

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We have received from Messrs. Newton and Co. their latest catalogue of Optical Lanterns and Slides. This includes a marvellous collection of views of all sorts and kinds, but we would especially notice the complete series in astronomical and in physical subjects.

Another novelty has recently been introduced by this firm and may be seen at their establishment in Fleet Street. It is called the "Sympathetic Pendulums," and consists of two weights suspended by springs from a bar of wood. When one weight is pulled down and released, it vibrates up and down for a certain time, but then seems to impart its motion to the other weight which starts bobbing up and down, while the first rests perfectly still. But in due course the second weight comes to rest and the first again starts its motion.

We have received, among others, an interesting catalogue of **Meteorological Instruments** from Messrs. Pastorelli and Rapkin, with equipment sets for meteorological observations. Also one from Messrs. Darton and Co. on **Electrical Novelties**, many of which form suitable presents for this season of the year. Several new **Electrical Instruments** are described in a set of leaflets issued by the Cambridge Scientific Instrument Company, Limited, and Messrs. Taylor, Taylor, and Hobson send a new list of their **Cooke Lenses** which is worth perusal by photographers.

XUM

# MICROSCOPY

*Conducted by* F. SHILLINGTON SCALES, F.R.M.S.

## Elementary Photo-micrography.

(*Continued from page* 308.)

THE room should now be darkened and a piece of white paper held in the beam of light coming from the bull's-eye. By moving this backwards and forwards an approximate position can be found where the light comes to a focus, and by slightly moving the bull's-eye itself this focus will be found to lengthen and shorten inversely as the corresponding conjugate focus from the lamp-flame lengthens and shortens. When the bull's-eye is adjusted to give parallel light the disc of light upon the paper should be of the same size as the bull's-eye, and should remain of the same size, neither more nor less, whether the paper be brought towards the illuminant or receded, and when looked through directly, the bull's-eye should be full of light at all distances. Unfortunately, the ordinary bull's-eye has so many aberrations inherent to its simple form of construction that only approximately parallel light and only approximately focussed light can be obtained by its means. The ordinary so-called "aplanatic" bull's-eyes are only a degree better, and it is here that the advantage of a really well-corrected condenser such as that of Mr. Conrady (see "KNOWLEDGE" for June, 1905, page 138) becomes evident. A word may be said concerning the large condensers, six inches or so in diameter, found on some Continental photo-micrographic stands. They, of course, take in a large amount of light, but they take in more, as Mr. Conrady says, than the objective can utilise, and, in addition, they generally consist merely of a couple of simple uncorrected plano-convex lenses. The second method of adjusting the condenser is to throw parallel or approximately parallel light upon the sub-stage condenser direct, and with an ordinary bull's-eye this gives as good or even better results than the method of focussing 10 inches behind the condenser just mentioned. Of course, were the light really parallel, the sub-stage condenser would bring it to a focus upon the object once more, but this does not happen in practice. The third method is to project the light into the plane of the objective itself, and this is generally done with low powers, especially those planar lenses of three inches or more focus, which are used for low power work. By this means the whole field can be uniformly illuminated.

But we now come to the most important adjustment of all, namely, the due centring of all the optical appliances mentioned, and it is here that the worker will feel the full advantage of those means of vertical and horizontal adjustment for each piece of apparatus mentioned previously. First set up the microscope horizontally so that the eye-piece end is connected with the camera, and make the light-tight connection. Place the illuminant a foot or more beyond the sub-stage so as to shine through the tube. Then screw in a low power objective and examine the disc of light upon the ground-glass screen of the camera.

*(To be continued.)*

## Royal Microscopical Society.

November 15, at 20, Hanover Square, G. C. Karop, Esq., M.R.C.S., vice-president in the chair. The Curator explained the Lucernal and Solar microscopes by Adams, presented to the Society that evening by Mr. Wynne E. Baxter. They were described by the maker in the "Essays on the Microscope," published by him in 1787. Dr. Hebb exhibited a magnifier made by Messrs. Taylor, Taylor and Hobson, of Berners Street, and Leicester. It was intended for focussing in photo-micrography, being placed against the ground-glass screen, and was provided with an adjustable draw-tube and a screw ring to clamp the same. Dr. Hebb also exhibited a turn-table, the joint invention of Mr. A. Flatters and Mr. Wm. Bradley. It was driven by clock-work and designed for turning oval cells and ringing oval mounts from any size up to 3 by $1\frac{1}{4}$ inches. By means of this turn-table, it was also possible to run a ring around a needle point, to turn circles, or to strike a straight line. An additional chuck, by means of which square covers also could be sealed, was not satisfactory in performance. The Chairman, whilst remarking on the ingenuity of the instrument, observed that it was doubtful if anyone present at the meeting would have occasion to mount objects in such numbers as to need so elaborate an apparatus. Mr. R. W. Paul sent for exhibition a Nernst lamp, for use with the microscope and for enlarging photographs, but was unfortunately unable to be present to explain its advantages. Mr. F. W. Watson-Baker exhibited a series of dissections of the Tsetse fly and its Trypanosomes, from South Africa, also a specimen of the larva of Ochromyia, together with the perfect insect. The larva also comes from South Africa and lives in the sandy earth, attaching itself to the flesh of natives and causing troublesome wounds. There was also a specimen of the ova of *Schistosoma Sinensis*, found in the body of a Chinaman, who died at Singapore.

## The Quekett Microscopical Club.

The 425th ordinary meeting of the Quekett Microscopical Club was held on November 17, at 20, Hanover Square, W., the Rt. Hon. Sir Ford North, F.R.S., a Vice-President, in the Chair. There was, as usual, a crowded meeting.

Mr. H. Taverner, F.R.M.S., described a method of finding the depth of cells sunk in glass slips, by means of an engineer's internal depth gauge, reading with a vernier to within $\frac{1}{50}$ of a millimetre. He had found this a very ready and accurate method of judging the depth of cell required for objects to be mounted without pressure, whose thickness was already known.

It had been announced that the President, Dr. E. J. Spitta, F.R.A.S., F.R.M.S., would read a paper "On some Experiments relating to the Insect's Compound Eye," but owing to his unavoidable absence through illness, a lecture by Mr. Frank P. Smith on "Spider Eyes," was substituted. After describing the differences between the two distinct types of simple eye which had been found in spiders, and which were distinguished as "nocturnal" and "diurnal" eyes, the lecturer proceeded to describe the arrangement of the eyes in the various families, which was found to be more or less connected with the life habits of the animal. He then described some of the abnormal types which had been observed and speculated as to their probable origin and meaning. A discussion followed in which several members took part.

Microscopists desirous of joining the Club at the commencement of 1906, should communicate with the Hon. Sec., Mr. A. Earland, 61, Denmark Street, Watford.

## Unmounted Micro-Objects.

Mr. R. G. Mason, of 69, Clapham Park Road, S.W., sends me specimens of a series of interesting objects ready prepared for mounting, or requiring only soaking in spirits of turpentine beforehand. These are very suitable for beginners, and others would do well to obtain the list and peruse it, as by obtaining some of these sections they can, with a minimum of trouble and expense, add many interesting slides to their cabinets. Many of the botanical sections are double stained, nearly all are arranged in typical sets, and the cost only averages from one penny to three halfpence per slide. Full directions for mounting are sent with each series. Mr. Mason also sends me specimens of completely mounted objects, amongst which I may mention a fine section of limestone from Llanymynech showing unusually perfect fossil remains.

## Notes and Queries.

*S. C. Mitra, Bombay.*—There is no book which deals specially with the structure of fibres under polarised light, the fact being that examination with polarised light is rather an aid than a principle. It seems sometimes to show up the central lumen and the striations, &c., of fibres very clearly. With regard to books, Hertzberg's "Paper Testing," which I recommended to a correspondent last month, has two large plates of excellent drawings of fibres, and Cross and Bevan's "Text-Book of Paper-Making" has an illustrated frontispiece of photo-micrographs; but the first-mentioned book would probably suit your purpose best. I am afraid I cannot promise a series of articles on micro-chemical reactions for fibres, as, with the exception of those I gave in my articles on "Fibrous Constituents of Paper," they are practically non-existent.

*T. H. Russell, Edgbaston.*—By projecting the image of the lines on a micrometer-scale on to a sheet of paper by means of a camera-lucida, marking the lines, and then, without disturbing any adjustments other than those necessary for re-focussing, replacing the micrometer-scale by the object-slide, and again marking the paper, you obtain identical values of magnification of both the markings on the micrometer-scale and of the object you want to be measured. The matter is not affected by any magnification or tube-length problems. You have marked on the sheet of paper magnified lines $\frac{1}{10}$ or $\frac{1}{100}$ of a millimetre apart, or whatever it may be, and you use these for the estimation of the size of the object. The camera-lucida is put ten inches from the table, because the normal visual distance is ten inches, but it is an arbitrary distance, selected for this reason, and has nothing to do with tube-length. If you are short-sighted you will *see* objects through the microscope smaller than the marks you have made upon the paper, because you do not form your virtual image 10 inches away, but less, and so get less magnification out of the microscope than an observer with a normal eye. The tube-length, of course, affects the total magnification, inasmuch as an objective used with a 6-inch tube only gives six-tenths of the *initial* magnification of the same objective used with a 10-inch tube. Then this initial magnification, whatever it may be, according to objective and tube-length, is multiplied again by the independent eyepiece magnification (hence the term "compound" as compared with a hand lens or "simple" microscope). The magnification of any one eyepiece is invariable and independent of tube-length. It is the objective which varies in this way, though most opticians' catalogues would lead you to think the contrary. Let me add that objectives are corrected for either short or long tube, and should be used with that length only for which they are corrected. The definition of the term "tube-length" is unfortunately vague; it may be "optical," or "mechanical," and even then different makers have different methods; but you will not be far off if you take the "mechanical" tube-length and decide to measure this from end to end of your tube when both objective and eyepiece are out, especially if you use uncapped eyepieces.

*C. A., Surrey.*—It is not easy to make a suggestion as to suitable subjects for investigation unless one knows something of one's correspondent's tastes and acquirements. There is one practical suggestion that I can make to you, however, out of many. Did you read Mr. Warburton's articles on "Mites" which appeared in these columns in May and June, 1904? If not, I would suggest your getting these numbers (if you have not already got them) and reading the article. It is a subject greatly neglected, and anyone who takes it up is sure to find many new species, for all of which he will get credit. They are very minute, and are found under loose bark, in lichen and moss, in fact, in any moss-grown wall or any coppice, and a bagful of material from an afternoon's walk will afford an evening's absorbing occupation. I know Mr. Warburton would be glad of help in collecting and examining, and I should be very pleased to put you in communication with him if you think well of my suggestion.

*R.K.H., Woolwich.*—I am very pleased to answer so pertinent and practical a query. Many workers with the microscope find themselves handicapped and their energies wasted and misdirected by just such want of preliminary scientific training as you deplore. Too many leave the matter helplessly, others obtain some standard and too often highly technical text-book on some special subject with the intention of reading it, and soon give it up in despair, discouraged at its complexities. It is a mistake to suppose that a man must undergo a course of training in a scientific laboratory if he is to do any good work. It is a great help to him if he can do so, and in certain subjects it is a necessary both for education and for self-discipline; but a man can do much by self-education if he has the root of the matter in him and will school himself to go steadily and consecutively through a prescribed course of study. It is essential that such study should include both reading and practical work, and the importance of the latter as a means of understanding the former can hardly be over-emphasised. To begin with Schäfer's "Essentials of Histology" is quite useless for your purpose. It is meant for medical students only, and is in many respects a more advanced book than it professes to be. You could scarcely understand it, and certainly not appreciate it, without the training in human anatomy and in physiology which invariably accompanies the study of the subject, even if you had the necessary sections at hand to examine. Preliminary biological study divides itself into two heads—zoology and botany—and though you will probably not wish to go far in the former, you can go much further in the latter. When I say you will not go far in the former, I mean that you will probably confine yourself for the most part to the study of invertebrate animals. What I would suggest your doing is this. Get Parker's "Practical Zoology" (Macmillan), and read and work through the chapters on unicellular and multicellular animals, Amoeba, Paramoecium, Vorticella, Hydra, &c., obtaining the animals and dealing with them according to the explicit directions in the book. Then go on to the Earthworm and dissect it out carefully, also according to instructions, and if you care to go on further you can dissect the Crayfish, the Mussel, Amphioxus, and the Frog. I do not know whether your enthusiasm will induce you to continue further with the Dogfish and the Rabbit! The Frog, however, that martyr to science, you should certainly study carefully, and half the book deals with this animal. As companion text-book you cannot do better than read Shipley and McBride's "Zoology," published by the Cambridge University Press, which is specially written for the zoological course in the University of Cambridge. For the botanical side of Biology get Strasburger's "Practical Botany," and work carefully through it chapter by chapter. You will find most detailed practical instructions on every point, and I am not sure that you had not better begin with the botanical side first, but that is a matter for yourself. Many of the specimens you can obtain for yourself, other zoological ones you can get from Mr. Bolton, of Birmingham, and botanical subjects from Messrs. Backhouse, of York. I can scarcely insist too strongly on the educational value of such a course as I have mapped out, if conscientiously and systematically worked through. But it should not be attempted in any other way. If you want help or explanation on any point as you go on, I shall be very glad to assist you as far as I can.

[*Communications and Enquiries on Microscopical matters should be addressed to F. Shillington Scales, "Jersey," St. Barnabas Road, Cambridge.*]

# The Face of the Sky for January.

By W. SHACKLETON, F.R.A.S.

THE SUN.—On the 1st the Sun rises at 8.8 and sets at 3.59; on the 31st he rises at 7.44 and sets at 4.45.

The earth is nearest the Sun on the 3rd, when the Sun attains his maximum apparent diameter of 32′ 35″.

Spots are numerous, whilst prominences as shown by recent spectroscopic observations are particularly active.

The position of the Sun's axis and equator is shown in the following table :—

| Date. | Axis inclined from N. point. | Centre of disc S. of Sun's Equator. |
|---|---|---|
| January 1 .. .. .. | 2° 22′ E | 3° 11′ |
| ,, 11 .. .. .. | 2° 29′ W | 4° 17′ |
| ,, 21 .. .. .. | 7° 15′ W | 5° 15′ |
| ,, 31 .. .. .. | 11° 36′ W | 6° 2′ |

THE MOON :—

| Date. | Phases. | H. M. |
|---|---|---|
| Jan. 2 .. | ☽ First Quarter | 2 52 p.m. |
| ,, 10 .. | ○ Full Moon | 4 37 p.m. |
| ,, 17 .. | ☾ Last Quarter | 8 49 p.m. |
| ,, 24 .. | ● New Moon | 5 9 p.m. |
| ,, 4 .. | Apogee | 4 0 p.m. |
| ,, 20 .. | Perigee | 6 12 a.m. |

OCCULTATIONS :—

| Date. | Star's Name. | Mag. | Disappearance. | | Reappearance. | | Moon's Age. |
|---|---|---|---|---|---|---|---|
| | | | Mean Time. | Angle from N. point. | Mean Time. | Angle from N point. | |
| | | | p m. | | p.m. | | d. h. |
| Jan. 4 | ξ² Ceti .. .. .. | 4·3 | 4.12 | 104° | 5.10 | 207° | 9 12 |
| ,, 7 | B.A.C. 1526.. .. | 5·8 | 6.53 | 100° | 8.2 | 230° | 12 15 |
| ,, 14 | σ Leonis .. .. | 4·1 | 11.1 | 134° | 11.58 | 264° | 19 19 |

THE PLANETS.—Mercury (Jan. 1, R.A. 17h 7m; Dec. S. 20° 35′. Jan. 31, R.A. 19h 57m; Dec. S. 22° 17′) is a morning star in Sagittarius, and is at greatest westerly elongation on the 4th, when he rises about 6·15 a.m. This elongation is not a very favourable one.

Venus (Jan. 1, R.A. 17h 59m; Dec. S. 23° 26′. Jan. 31, R.A. 20h 40m; Dec. S. 19° 28′) appears in close proximity to the Sun, and is practically unobservable.

Mars (Jan. 1, R.A. 22h 24m; Dec. S. 11° 2′. Jan. 31, R.A. 23h 48m; Dec. S. 1° 50′) is an evening star in Aquarius, and appears in the sky a little to the east of Saturn. Near the beginning of the month the planet is on the meridian about sunset, but in consequence of now being at a great distance from the earth he appears but a feeble object.

Jupiter (Jan. 1, R.A. 3h 40m; Dec. N. 18° 41′; Jan. 31, R.A. 3h 38m; Dec. N. 18° 41′) is due south at 8 p.m. near the middle of the month. The planet is describing a retrograde path near the Pleiades, is at the stationary point on the 21st, after which his motion is direct or easterly. The equatorial diameter of the planet on the 14th is 45″·0, whilst the polar diameter is 2″·9 smaller. The planet is very favourably situated for observation, and even in very small telescopes his belt-like markings and attendant moons form an interesting object.

The following table gives the satellite phenomena visible in this country before midnight :—

| Date. | Satellite. | Phenomenon. | P.M.'s. H. M. |
|---|---|---|---|
| Jan. | | | |
| 1 | I. | Tr. I. | 9 41 |
| | II. | Tr. I. | 9 46 |
| | I. | Sh. I. | 10 36 |
| | II. | Sh. I. | 11 36 |
| | I. | Tr. E. | 11 53 |
| 2 | I. | Oc. D. | 6 57 |
| | I. | Ec. R. | 10 3 |
| 3 | I. | Sh. I. | 5 5 |
| | III. | Oc. D. | 5 25 |
| | I. | Tr. E. | 6 20 |
| | III. | Oc. R. | 7 10 |
| | I. | Sh. E. | 7 18 |
| | II. | Ec. R. | 8 43 |
| | III. | Ec. D. | 9 16 |
| | III. | Ec. R. | 10 59 |
| 8 | I. | Tr. I. | 11 30 |
| 9 | I. | Oc. D. | 8 45 |
| | I. | Ec. R. | 11 59 |
| 10 | I. | Tr. I. | 5 57 |
| | II. | Oc. D. | 6 40 |
| Jan. | | | |
| 10 | I. | Sh. I. | 7 0 |
| | I. | Tr. E. | 8 10 |
| | III. | Oc. D. | 8 57 |
| | I. | Sh. E. | 9 13 |
| | III. | Oc. R. | 10 46 |
| | II. | Ec. R. | 11 18 |
| 11 | I. | Ec. R. | 6 27 |
| 12 | II. | Sh. E. | 6 11 |
| 14 | III. | Sh. E. | 5 17 |
| 16 | I. | Oc. D. | 10 35 |
| 17 | I. | Tr. I. | 7 46 |
| | I. | Sh. I. | 8 55 |
| | II. | Oc. D. | 9 4 |
| | I. | Tr. E. | 9 59 |
| | I. | Sh. E. | 11 8 |
| 18 | I. | Ec. R. | 8 23 |
| 19 | I. | Sh. E. | 5 37 |
| | II. | Sh. I. | 6 12 |
| | II. | Tr. E. | 6 25 |
| | II. | Sh. E. | 8 50 |
| Jan. | | | |
| 21 | III. | Sh. I. | 7 19 |
| | III. | Sh. E. | 9 19 |
| 24 | I. | Tr. I. | 9 37 |
| | I. | Sh. I. | 10 51 |
| | II. | Oc. D. | 11 31 |
| | I. | Tr. E. | 11 50 |
| 25 | I. | Oc. D. | 6 54 |
| | I. | Ec. R. | 10 19 |
| 26 | I. | Tr. E. | 6 18 |
| | II. | Tr. I. | 6 20 |
| | I. | Sh. E. | 7 33 |
| | II. | Sh. I. | 8 51 |
| | II. | Tr. E. | 8 56 |
| | II. | Sh. E. | 11 28 |
| 28 | II. | Ec. R. | 5 48 |
| | III. | Tr. I. | 6 17 |
| | III. | Tr. E. | 8 14 |
| | III. | Sh. I. | 11 20 |
| 31 | I. | Tr. I. | 11 29 |

"Oc. D." denotes the disappearance of the Satellite behind the disc, and "Oc. R." its re-appearance; "Tr. I." the ingress of a transit across the disc, and "Tr. E." its egress; "Sh. I." the ingress of a transit of the shadow across the disc, and "Sh. E." its egress.

Saturn (Jan. 1, R. A. 22h 8m; Dec. S. 13° 9′. Jan. 31, R. A. 22h 20m; Dec. S. 12° 0′) is now getting to the west and will soon be out of range; near the middle the month the planet sets about 7.30 p.m. The northern surface of the ring is presented to us and we are looking upon it at angle of 9°.

Uranus (Jan. 1, R. A. 18h 21m; Dec. S. 23° 37m) appears in close proximity to the Sun and is therefore unobservable.

Neptune (Jan. 17, R. A. 6h 37m; Dec. N. 22° 13′) is due south about 11 p.m. near the middle of the month. The planet is situated in Gemini, some 6° east of the star $\mu$ Geminorum, but in small telscopes it is difficult to identify among the numerous stars in the same field of view, but he can be detected by his slight motion if observations are made on several successive nights.

METEOR SHOWERS :—

| Date. | Radiant. R.A. | Radiant. Dec. | Name. |
|---|---|---|---|
| | h. m. | | |
| Jan. 2-3 | XV. 20 | +53° | Quadantrids. |
| ,, 17 | XIX. 40 | +53° | $\theta$ Cyganids. |

Minima of Algol may be observed on the 15th at 11.4 p.m., the 18th at 7.53 p.m., and the 21st at 4.42 p.m.

$o$ Ceti (Mira) should be watched, as it will probably reach a maximum during the month.

TELESCOPIC OBJECTS :—

Nebulæ.—Orion Nebula, situated in the sword of Orion, and surrounding the multiple star $\theta$, is the finest of all nebulæ; with a 3 or 4 inch telescope, it is best observed when low powers are employed.

Crab Nebula (M 1), in Taurus, situated about 1½° north-west of $\zeta$ Tauri in R.A. 5h 29m, Dec. 21° 58′ N.

Clusters.—M 37, situated in Auriga, is one of the finest clusters, and very compact, its position is R.A. 5h. 46m., Dec. 32° 32′ N.

DOUBLE STARS.—$\beta$ Orionis (Rigel), mags. 1 and 9, separation 9″. On account of the brightness of the principal star, this double is a fair test for a good object-glass of about 3-inch aperture.

$\delta$ Orionis, mags. 2 and 7, separation, 53″; easy double.

$\zeta$ Orionis, triple, mags. 3, 6, and 10, separation 25″· and 56″; rather difficult in a 3-inch telescope.

$\lambda$ Orionis, mags. 4 and 6, separation 4″·5; pretty double.

$\sigma$ Orionis, triple, mags. 4, 8, and 7, separation 12″·5 and 42″.

**SUPPLEMENT.**

# London's Transformation.

## A Suggestive Sketch of Days to Come.

(*Continued from page* 314.)

By TEMS DYVIRTA.

[Cornelius Tush was a great American financier, whose modes of business were perhaps not always quite above suspicion. He had hit upon the great idea of diverting the course of the Thames so as to cause the river to flow away to the country, and leave its dry bed in London available for building sites. He had made business arrangements with a number of people, had formed a large Company to make the deviation, and finally the work was completed. Tush, however, was sorely disappointed with the treatment he had received in England, where many people looked askance at his methods, and had returned to America.]

### CHAPTER VIII.

LIBERTIA STREET.

A period of peaceful repose having healed the soreness of his heart, Tush had returned to England to view the outcome of his ambitious scheme.

For the third time he stood on Westminster Bridge and leant upon the parapet to gaze on the scene below. And well might he ponder, for what a different sight now presented itself to his eyes to that on which he had looked so long ago, when nothing but a sea of turbid waters flowed beneath, and later, when the busy hum of machinery resounded over the irregular masses of heaped-up earth and woodwork. What he now looked down upon was an extensive view of the finest street in all the world. A thoroughfare worthy of the great city of London. "Libertia Street" ("Avenue" was originally suggested, but the old English "street" finally adopted) is over 200 feet wide. On either hand rise magnificent new buildings of imposing architecture. The sound of the hammer and of the trowel still resounds in the air, telling of the new structures arising among the scaffoldings between. Here, on the right, is the huge "Hotel Thames," with its tiers of balconies rising high above the bridge. There to the left, with its gilded statuettes, is the Royal Thames Theatre. Next that of the prettily turreted building of the new Radical Club, while opposite is the great block containing the "World's Emporium," and further on is the great National Opera House. Away in the distance are the towers of the new Palace of Justice. Besides the many handsome detached edifices are the rows of shops and business houses. Their ground floors abut on the street, and contain for the most part the parcels offices and packing stores, readily available to the carts in the street, while, in many cases, vehicles can drive in through porticos to inner court yards. On the roofs of these lower stories runs a wide pavement for pedestrians. At intervals are inclines or steps leading to the roadway below, and foot-bridges span the side streets. Glass verandahs jut out over the shop fronts, giving shelter from the rain, while not darkening the display of tempting goods in their windows. Above them the great buildings rise to six or eight stories high, even looking down from their parapets on their poor old kindred of the high-level town around them.

Every building is of artistic design, and all now look so bright and clean in their newness, that a very pleasant effect is presented to the eye. Down the centre of this great thoroughfare runs an avenue of fresh green trees, bordering a gravel walk, whereon are seats and chairs, shelters from the sun and rain, drinking fountains, newspaper Kiosks, coffee stalls, and retiring rooms; all beautifully and tastily arranged, at hand, yet not interfering with the traffic. Even monuments are in course of erection in suitable spots; these are not ugly bronze figures of men in everyday attire standing on solid blocks of stone, with blackened faces, unrecognisable as representatives of their originals. Such statues are no more picturesque than the passers-by themselves; but here are artistically-grouped statuettes on ornamental pedestals.

On either side of the central avenue are cab-stands and space for waiting vehicles, and tram lines run along outside. Then comes the enclosed road reserved for the out-of-date horse-drawn traffic, which, of course, is prohibited from sullying and wearing out the clean asphalt, on which the horses would, moreover, be slipping down and running away. Outside this are the broad, open, asphalted roads, now teaming with traffic overflowing from the much congested thoroughfares of the old city, and forming a splendid unimpeded route from East to West of London. For this great highway extends along the course of the old river as far as the new Docks at London Bridge. There a fine wide wharf runs across the river, forming a fitting point of departure for the smaller passenger boats leaving the port of London. What a pleasant change from the dirty old crowded wharves of olden days! Any day one may see ten or a dozen steamers lying with their sterns towards the wide quays, embarking heir passengers as trains do at a large railway terminus.

Along the old embankment (the stone facings of which have now been moved to line the sides of the Canal) are the shop fronts of the new houses whose lower floors abut the fine, though comparatively narrow streets which run along parallel to the great Libertia Street.

To the south of the main thoroughfare runs a second narrow street, and in this are some of the huge buildings affording comfortable accommodation for thousands of the working classes. All are built on the latest approved methods and with all the modern appliances for living in health and comfort. Each family has its own suite of rooms, with balconies and window gardens, and everything that a poor Londoner can expect. Many of their windows overlook the Canal, which important waterway connects the docks with the various city warehouses and enables water traffic to be conducted from the lower to the upper Thames.

It was a bright sunny day, for days are generally brighter now; no longer do such dense fogs hang about the valley of the old river. Fog is but the visible effect of aqueous vapour suspended in the air; without the expanse of cold humid water and damp earth this could not exist. The minute particles of smoke, which, dampened by the vapour, form the pall which used to hang over the city, are now dry and fall to the ground as dust, leaving the sunshine to warm the air and beautify the surroundings.

Yet was Cornelius dull. "Uneasy lies the mind that grabs the gold!" Troubles seem unending. A journey to the States and a sojourn there of eighteen months should have appeased the public mind. Their new plaything should have caused Londoners to forget their petty squabbles with the donor. But no! he had come back to find himself an outcast, shunned by all. He had arranged to see his solicitor that day and to discuss with him the unsatisfactory aspect of affairs. But first he would have a look around the new city of his creation. Descending by some steps, he pursued his way along the great broad walk beneath the bridge. What a grand sight now met his gaze! For

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a magnificent open space lay to his right, laid out with flower beds and grass plots, and beyond a truly noble flight of steps, broken with balustrades and statues, forming the grand approach to the historic terrace from which rose that noble pile, looking so much grander when seen from below, of the Palace of Westminster.

For some time he stood wrapped in admiration. He felt that the British House of Representatives now really equalled that of the States; for how would the Capitol at Washington appear, from an architectural point of view, were it situated in a depression, and looked down upon instead of being looked up to?

Further on, great houses with their shop fronts again walled in the streets. To the left was a bridge spanning the Canal, now packed with barges being towed up and down to the various wharves lining its sides. All was changed and altered! Like the inhabitants themselves! The very buildings in their grandeur seemed to cut the millionaire dead! Calling up a motor car he jumped in and was whisked off to interview his lawyer and hear how things were developing. Rapidly he was sped along the smooth asphalt down the great thoroughfare. Onward he went under Westminster Bridge, past the great Northumberland Avenue approach whence a glimpse of Trafalgar Square could be obtained, till, passing up on to the Embankment near Waterloo Bridge, he was deposited before the great buildings of the New Temple facing the Inner Temple Gardens. Here were situated numbers of new chambers for barristers and solicitors, who, in their increased numbers had flooded out the older rookeries of legal experts.

Entering the offices, he there found assembled some half-dozen men, his associates in business and others. The grey-haired solicitor eyed him gravely as he entered, and spoke earnestly in a hushed undertone. Serious, indeed, was the import of his words. The interview did not last long. Tush, for a wonder, was very taciturn, and said but little in reply to the anxious exhortations of the lawyer. Presently he turned and caught sight of Bateson, who was standing whispering mysteriously to one of the others with his eyes fixed on Cornelius. "*You* have brought all this on me," roared Tush, livid with rage. "You scoundrel!" Then, turning to the others, he recognised some of the prominent shareholders in the great company, some who had been addicted to asking awkward questions. "That I," he muttered through his teeth, "I, who could buy up this whole blessed city, that I should receive such insult! Such ignominy! You dare to threaten me, do you? Call me 'swindler' and have me up in your dirty Law Courts for fraud! No, no, my friends. You'll find *that* won't pay. Why, I could put you down a million apiece to keep your tongues from wagging, aye, and not feel it. Only I *won't*. I'll have nothing more to do with you darned Britishers. I've got all the dollars I want out of you, and now I can face my own countrymen, thank God! Only I should like to spoil all that fine street I've made for you first. Thankless curs!" And turning on his heel he left the room.

## CHAPTER IX.

### The New Thames.

Happy is the man who amidst life's storms has ever at hand a harbour of safety wherein he can obtain rest and peace; a home of refuge for his troubled mind, a comforter and friend, in whom he can confide, and lucky was Cornelius in having such a possession still to fall back upon.

Returning to his rooms in the palatial Thames Hotel he found his faithful Alma and his petted and affectionate daughter. What soothing influence they brought upon his agitated brain! "Alma," he said calmly, "we must leave this cursed country. Never again shall I put foot in it. We will return to our own old States, and there we may find peace and happiness, but not here; we must be off by the first boat." His tactful wife soon grasped the situation. She saw how greatly her husband was worried over his business, and she, too, knew how dangerous that was for him whom the doctors had declared possessed of a weak heart. She soothed him gently, but still she divined the serious causes that influenced his intentions. "Cornelius," she replied, "you are worried and upset. We cannot start to-day. Let us, then, go for one more delightful quiet sail on the lovely river. It will do you good, you know it always does."

So leaving their rooms the trio went forth, bent on enjoying the last few hours they might have in England. How little did they think that for one of them it was the last few hours in any land!

Within a short space of time they were rattling along in the train through the southern districts of London, when, on passing clear of a large factory, a brilliant scene was presented to their eyes. A peaceful, pleasurable sight, yet one to sicken and embitter Cornelius' feelings! Another of his creations to be presented to his enemies, for the train approached a long, a very long bridge, and this bridge spanned a broad stretch of water, the New Thames! Looking down from this eminence a good view of the grand river was obtainable. Dotted about on this were numerous sailing boats and small yachts, beating their way hither and thither, their white sails looking so clean and bright against the blue water and the green trees beyond, for there on either bank were the newly laid-out gardens of many little villas cropping up like mushrooms all around. This splendid artificial lake, here of great width, but further on narrowing into the gorge of the great cutting through the Surrey Hills, formed, indeed, the much-needed playground for boat-loving Londoners. How much appreciated it was by the old hands who had steered their craft on the narrow and enclosed reaches of the old Thames! And what lovely little surburban retreats there were springing up upon its rising banks! In a few years more, when those young saplings had attained mature dimensions, would not those wooded slopes compare even with the picturesque confines of the Bosphorus?

Soon the party had alighted at the little station now crowded with people clad in white flannels and straw hats, for it transpired that a regatta was being held. Thence they walked down to the river-side and on to the landing stage of "Tyler's," and soon were seated in the smart little centre-board yacht, the *Water Witch*. This vessel had been bought by Cornelius but a few days previously as a means of escape from that society which he now so disliked. But a few minutes more and the little ship was sailing off gaily before the strong gusts of wind which rippled over the deep blue water, breaking up the monotony of colour from the ice-like calm under the windward banks.

No feeling is pleasanter, no motion more calming to the mind, than that of gliding in a sailing boat through the water in a fresh breeze, with the gurgling sound of the tiny waves rippling against the sides of the vessel.

Cornelius, ever determined to have the supreme command in all things, took the helm and piloted the yacht on its voyage. First they sailed over to where the regatta was being held. The course, clearly marked out with buoys, almost as distinctly as a race course

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ashore, had to be crossed at one of the points arranged for the purpose at stated intervals. "Heaving to" for a time, the party were able to watch one of the races, which were well seen, too, for the whole length of the course by the hundreds of spectators comfortably seated about on the slopes of the rising river bank. How preferable to the crowded towing paths of the old Thames on such occasions!

This wide portion of the river had been so constructed in conformity with one of the stipulations of the Government, influenced by a deputation from the combined sailing and rowing clubs. Lower down the rising hills involved large and expensive cuttings, and there, consequently, the river was narrower.

Having taken a turn among the mass of boats full of onlookers, and past some of the launches lying away while their occupants consumed their champagne and ices, the little family party decided on taking a trip further down the river; further from the "madding crowd." The *Water Witch* soon sailed in under the lee of the great cutting and was almost becalmed, drifting slowly along with the current. Steering now being unnecessary, if not impossible, Cornelius left the tiller, and making fast the main sheet to prevent the boom swinging over, reclined at his ease close to where his wife and daughter were sitting. This was truly bliss! What need to quarrel with one's fellow creatures when one's time could be spent drifting thus leisurely in the quiet summer evening so far from all worries and troubles, and even able to avoid the inquisitive and sometimes scornful gaze of passers-by.

Everything seemed peaceful and still. Other boats were being sailed and rowed about, but none were near enough to disturb the repose of the occupants of the yacht.

All of a sudden the wind freshened. They had drifted on beyond the bluff to where a valley ran down towards the river. Before the party realised their position a strong squall caught the sail now tightly fixed by the main sheet. The boat gently heeled over more and more. Cornelius sprang to the helm, but in his hurry tripped and fell sprawling to the lee side. This extra weight suddenly thrown on the beam was the finishing touch, the gunwale sank under the water, the vessel rapidly filled, and turned on its side, the mast and sail sinking under. All the occupants were thrown into the river. Libertia, an expert swimmer, had seized her father as she saw him rolling into the water, and now held him with one hand, as she clung to the half-submerged boat with the other. In vain they struggled to right it. Cornelius was no swimmer and could assist but little, and for some moments was so involved in gasping for breath and getting a firmer hold of the boat that he did not notice the absence of his wife. "Alma," he gasped, "Alma, are you safe?" But no response came. No response beyond the agonizing cry of Libertia, who plunged under water in the vain hope of seeing her mother. But never again was that fair form seen alive. Held down beneath the sail her last breath must have been soon drawn, and ere the witnesses of the disaster, who hurried their boats to the spot, had rescued the immersed couple, her body must have sunk beneath the depths of water which, but for her husband, would, perhaps, never have covered that spot. Poor Alma! That sweet accomplished, faithful wife and mother, whose life had always been such as any woman might envy; upright, self-sacrificing, and true, was gone for ever.

Many hours had passed before the body with its beautiful white face, calm and serene, was dragged from the river and laid on the bank while endeavours were vainly made to restore animation.

A few days more and all that was left of his beloved wife had been laid in their last resting place, not far from the banks of that treacherous stream, and Cornelius took his heart-broken daughter back to their own mother-country, bidding farewell, as he said, for ever, to this land of spite and thanklessness.

## CHAPTER X.

### SETTING THE THAMES ON FIRE.

It was in the early hours of the morning on the day following Tush's departure for America, when all the town was hushed in silence, or as near approaching that state as it ever is, one of the watchmen at the "World's Emporium" was going his rounds when he detected a smell of burning, and passing through the building to the department whence he thought it emanated, found the place full of smoke. He then suddenly noticed one of his mates lying on the floor apparently insensible. As a matter of fact, he felt somewhat suspicious at the time as he did not consider the smoke so thick at that spot as to cause asphyxiation, and he very easily aroused the watchman to consciousness. It was then discovered that a very extensive fire was raging, also that the "automatic sprinklers," which should have at once sent a deluge of water on the spot, had ceased to act, as though the water had been turned off. The alarm was quickly given, and in a very short space of time the fire brigade was busily at work subduing the flames. One after another motor fire engines came dashing along the empty streets, and drew up before the burning building. Hoses were soon got out and attached to the hydrants, and before long tons of water were being poured on the flames.

But whilst this was going on, a policeman on duty by the Canal near Southwark, noticed smoke issuing from a large new warehouse, and soon a second great conflagration was in progress. Urgent calls were issued to outlying stations, and the fire brigade had its hands full. A third fire was then reported down near the new Docks, and hardly had this been taken in hand than it was found that the upper floors of the Thames Hotel were ablaze. All this was a tremendous strain on the brigade, and it would have become a very serious matter, indeed, had it not been for two facts. Firstly all the houses had been constructed in conformity with stringent rules issued by the London County Council regarding various details for the prevention of fire. Such would have been impossible to apply to existing buildings, but these had been introduced after receiving the most careful attention when first it had become certain that a large number of new buildings were to be erected. It was then decided that this would be a great opportunity for introducing new regulations with regard to the construction of all edifices. All were to be fitted with automatic alarms (though in each of the present cases these had, for some unaccountable reason, failed to act). Among other details all were furnished with hydrants and stand pipes to suppy a copious amount of water under considerable pressure. Various means of escape, too, had to be provided, and fire-proof materials entered into the construction and fittings.

The second reason for the comparative ease of being able to subdue the flames was the ample water supply flowing from these hydrants. Great mains had been laid in the old river bed whence an inexhaustible volume of water came direct from the Thames. This arrangement proved to be of the greatest use for fire extinction, as a mass of water, almost to be comparable to a river itself, could be poured on the flames.

The fire raging at the hotel presented a most exciting

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spectacle to the great crowd which soon assembled. The guests dashing to the windows of their rooms were seen to cast out some simple folding ladders (in conformity with the printed directions in all the rooms), and by this means were enabled to reach the balconies below, whence, by the iron staircase, they could descend to the main balcony above the street. Hundreds of them in all variety of attire were streaming down the front of the building, looking for all the world like so many white ants whose nest has been disturbed. Owing to these excellent arrangements there was no loss of life in the enormous building.

Firemen, and even policemen and soldiers were, on the other hand, scaling the building with their ladders to direct thin jets of water in at the windows from the hose attached to the iron pipes, which conveyed a copious supply of water to the tops of the houses. The great, wide street, and the bridges that spanned it, formed advantageous coigns of vantage for the many thousands who had come to watch the sensational operations. Very soon, however, thanks to the timely measures which had been adopted, each of the fires was extinguished.

Then, as all the spectators wended their several ways homeward, tongues got wagging, and everyone was enquiring how so many fires originated at the same time all in this one new district. Later on other facts came to light. Eventually it transpired that some large insurance operations had been effected in the name of Tush. Then did some recall certain words used by that gentleman in the solicitor's office just prior to his leaving the country.

Many of those returning to their homes or going to their day's business made their way eastwards through the great markets under London Bridge. Now that old Covent Garden had been transformed and built over this was the centre whence Londoners obtained so much of their food supplies. Magnificent conservatory-like buildings rose on all sides, and the well-paved floor was kept scrupulously clean by lavish drenches of water.

Among the stream of those passing through, one man was noticeable, for in him we may recognise the agent, Bateson. Continuing his way into the purlieus of Bermondsey he might have been seen to visit certain low haunts, become engaged conversing and discussing matters with several well-known disreputable characters, and effecting certain monetary transactions with them. This done, he threaded his way back to the city. Later on Mr. Bateson might have been seen entering the colossal portals of the "Tush Buildings," situated just beyond Blackfriars Bridge. Ascending rapidly in the hydraulic lift, he was landed on the 11th floor, where were the offices of the Griffin Insurance Society. His business was, he explained, to claim on behalf of Mr. Tush, immediate payment with respect to insurance policies issued in his name on certain buildings situated in Libertia Street and that neighbourhood, which had been damaged by fire on the previous night. He explained that the reason of his somewhat sudden demand was because of Mr. Tush's departure for America. "But," retorted the manager, "this is just a matter on which I was requiring some information. I happened to meet Mr. Tush some days ago, and knowing that he had lately insured a number of buildings in very large amounts, I alluded to the matter, when, to my surprise, he denied having effected any insurances whatever." "Ah, you see," replied the agent, "Mr. Tush is a peculiar man. His hands are so full of business that he frequently forgets what little affairs he has transacted. Now I manage all these things for him and keep count of them, and I hold his power of attorney for transacting such business." Nevertheless, the manager was not at all satisfied, and as rumours had reached him with reference to suspicions as to the origin of the fire, he politely declined to redeem the policies pending further enquiries. Bateson was evidently somewhat disconcerted about this and left the office abruptly.

It was a hot, stifling day. In some of the older quarters of the town life seemed almost unbearable. Warm blasts of wind sent clouds of dust to thicken the air and fill the eyes and lungs of passers-by. The glaring rays of sun, almost tropical in its intensity, beat down upon the dry-mouthed, sweating wayfarers. Dust penetrated everywhere, and whence this dust? The disintegration of the road material by the continuous hammering of iron hoofs and crunching of iron-bound wheels, the refuse strewn over the streets by the horses, and the gravel scattered upon them to prevent the slipping during damp and frosty weather. But the new districts in the river-bed were better off. Foot passengers strolled beneath the green trees or shady verandahs, while the clean asphalt, unworn by the soft rubber tyres of the motors, emitted no dust, and the plentiful water supply enabled the roadways to be profusely sprinkled from the many stand-pipes.

Bateson wandered about uneasily trying to rest under the soothing influence of the shady trees in the centre of the street. He was cogitating on his future actions. Finally he decided, being somewhat apprehensive of what the future might bring, on getting together, while there was yet time, as much personal property as he could collect. With this object he walked off to the Bank of England. This national storehouse of wealth, emblematic of the mighty Empire, had long since outgrown the old buildings in Threadneedle Street, and was now contained in that splendid block extending from Cannon Street on the north and continuing south to its noble facade in Libertia Street, thus connecting the old city with the new. Business in London was now double what it was twenty years ago, and the Bank of England is but an index of its magnitude. As with many other institutions, it is difficult to comprehend how they could have been sufficiently enlarged to cope with the growth of trade and increase of wealth, had it not been for the utilisation of the Thames.

Passing through the grand entrance hall, Bateson hurried nervously along and visited one department after another (and the interior of this office may be compared to a small city in itself), endeavouring to effect the somewhat complicated business he had in hand. In due course it was all satisfactorily arranged, and he quitted the building to visit another of those great piles of offices towering into the sky, numbers of which had been erected in this neighbourhood, adding immensely to the much-needed business accommodation of the city.

Here he asked for an interview with the manager of another large fire insurance company. This time Mr. Bateson was still less fortunate than before, for certain inquiries had in the meantime been made and certain transactions come to light. The result was, that after being detained for a very considerable time in the waiting-room, the manager entered accompanied by another man, and after a few words of explanation, introduced the latter as an official from Scotland Yard, who would conduct Mr. Bateson to a certain place where further investigation was now being made as to the origin of last night's conflagrations. And it may here be added the result of these investigations were so unfavourable to that gentleman that for a long time afterwards he was not seen in public.

(*To be concluded.*)